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American Foundryman

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"The
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MAGAZINE
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The "business end" of a Brackelsburg Furnace Containing a Malleable Iron Charge

June 1945 — Solidification of Metals (p. 26). Malleable Iron Control (p. 31). Plaster Matchplates (p. 38). Microporosity in Magnesium Alloy Castings (p. 44). Sand Control Tests (p. 55). Properties in Sand Cast Bronzes (p. 61).

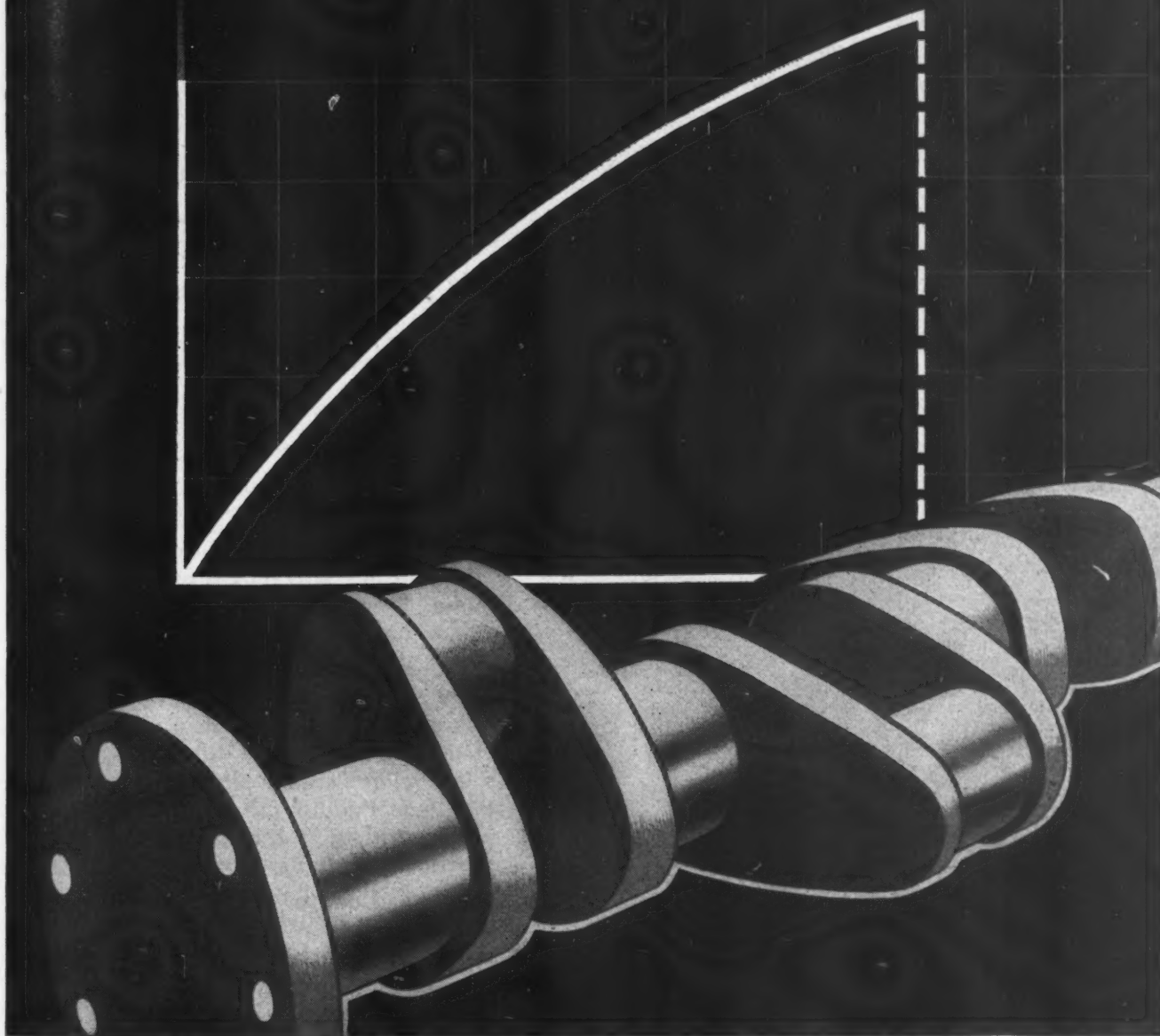
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American Foundryman

JUNE

1945

VOLUME VII
NUMBER 6

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WHO

ARE THE AUTHORS In This Issue?

The men whose names are shown on these two pages deserve the thanks of the industry for their contributions to the 1945 "Year-'Round Foundry Congress" . . . in many cases, completed in spite of cancellation of the Detroit convention.



C. C. Brisbois

In this issue: see *Improved Methods of Making Plaster Composition Match Plates* . . .

The author, a native of Ottawa, Ont. . . Graduated in 1912 from L'Academie de LaSalle, Ottawa . . . Following graduation, became a Molder and Core Maker at Ottawa Steel & Iron Castings Co., Ltd. . . . Appointed Assistant Superintendent in 1920 . . . Served as Foundry Foreman for Thomas Davidson Steel & Iron Foundry, Ottawa, until 1929 . . . At present, Foundry Superintendent, Robert Mitchell Co. Ltd., Montreal . . . Holds membership in both A.F.A. and A.S.M.



M. E. McKinney

Works Metallurgist, International Harvester Co., Hamilton, Ontario . . . Author of current paper on *Malleable Iron Control* . . .

Born in Wellington, Ohio . . . Began industrial career as a Sampler for American Sheet & Tin Plate Co., Vandergrift, Pa. . . . In 1915, Steel Chemist with Carnegie Steel Co., Braddock, Pa. . . . A year later, same position with United Engineering & Foundry Co., Vandergrift . . . Following World War I, he became Chief Metallurgist for Les Fonderies et Acieries de L'Anjou, La Possonniere, France . . . Returned to Avonmore, Pa. in 1920 as Chemist with Fahnestock Mfg. Co. . . . Returned to France in 1921 and became associated with Les Acieries de Genvilliers as Blowman and Melting Foreman . . . In 1923, became affiliated with International Harvester Co., Croix Works, Croix, France, as Works Metallurgist . . . In 1928, appointed European Chief Metallurgist to International Harvester Co. Brussels, Belgium . . . In 1939, assigned to the Geelong Works, Geelong,

Australia, for special service work . . . Returning to United States in 1940, engaged in malleable research work at Harvester's McCormick Works, Chicago . . . Special service work at Hamilton Works in 1941, and in 1942 appointed Works Metallurgist . . . Has contributed papers on malleable melting and annealing for various technical societies . . . An active member of A.F.A. and A.S.M.



Blake M. Loring

See paper: *Distribution of Mechanical Properties in Sand Cast Bronzes* . . . Co-authors and associates: R. G.

Hardy and R. H. Brouk . . . Mr. Loring is Metallurgist with the Naval Research Laboratory, Washington, D. C. . . . A native of New Hampshire (Laconia) in 1914 . . . Holds two degrees from the Massachusetts Institute of Technology—S.B. in Metallurgy (1937) and

Sc.D. in Metallurgy (1940) . . . Spent three years on teaching staff of M.I.T. . . . Joined the staff of Naval Research Laboratory in 1940 . . . Has contributed metallurgical papers on x-ray, steels, brass and bronze to various technical society meetings . . . Member of A.F.A., A.S.M., A.I.M.E. and American Association for the Advancement of Science . . . As a result of his research work, also listed in "American Men of Science."



Arnold Satz

Author of an interesting paper in this issue on *Elevated Temperature Test in Sand Control* . . . Metallurgist

for National Radiator Co., New Castle, Pa. . . . Birthplace Minneapolis, December, 1920 . . . Graduated from University of Minnesota in 1943 . . . Received a Bachelor of Metallurgical Engineering degree . . . Recently presented talk before Twin City Chapter of A.F.A. on "Relation Between Surface Finish and Machining Soundness of Gray Iron Castings" . . . Active member of A.F.A.

DISCUSSION WANTED!

The men who are recognized on these Who's Who pages each month have spent considerable time and effort in preparing their papers for presentation herein, and the value of their findings can be materially enhanced through discussion. Since oral discussion is not possible this year, written discussion is earnestly solicited!

Members of A.F.A. owe it to these authors to take a definite interest in their work. Written discussion should be forwarded direct to A.F.A. headquarters in Chicago, for publication in future issues of *American Foundryman*.



J. C. DeHaven

Co-author with L. W. Eastwood and James A. Davis . . . see: *Reduction of Microporosity in Magnesium*

Alloy Castings . . . Mr. DeHaven was born in Glenshaw, Pa. . . . Received A.B. degree from Dartmouth College in 1933 . . . Obtained his Master of Science degree from Carnegie Institute of Technology, 1935 . . . On entering industry, became associated with American Radiator & Standard Sanitary Corp., Pittsburgh, Pa., until 1941, as Chemist and Industrial Engineer . . . Joined Battelle Memorial Institute as a Research Engineer in 1941 . . . Prepared and pre-

sented before A.I.M.E. (1935) a paper on *Free Energy and Heat of Formation of Intermetallic Compound Cd Sb* . . . An active member of A.F.A. and A.S.M.

Ralph H. Brouk

Co-author (with B. M. Loring and R. G. Hardy) of Naval Research paper on Brass and Bronze in this issue

. . . Born in St. Louis, December, 1918 . . . Attended University of Illinois, 1936-1940 . . . Received his B.S. in Metallurgical Engineering from Missouri School of Mines, 1942 . . . Assistant Metallurgist, National Bearing Metal Corp., St. Louis, 1940 . . . Associate Metallurgist (1942-1944) with Naval Research Laboratory, Washington, D. C., Non-Ferrous Castings Section . . . Commissioned Ensign in U.S. Navy, 1944, and still assigned to Naval Research Laboratory . . . Member of A.F.A., A.I.M.E. and A.S.M.



Russell G. Hardy

Author (with associates R. H. Brouk and B. M. Loring) of Naval Research paper herein on *Distribution of Mechanical Properties in Sand Cast Bronzes*

. . . Born in Rockland, Maine . . . Received his technical education at Carnegie Institute of Technology, Pittsburgh, Pa. . . Became a Metallurgist on staff of Naval Research Laboratory, Washington, D. C., 1943-1945 . . . At present is a Chief Petty Officer, U.S. Naval Reserve, assigned to the Research Laboratory . . . A member of A.F.A. and American Society for Metals.

L. W. Eastwood

Co-author (with James A. Davis, J. C. DeHaven) of *Reduction of Microporosity in Magnesium Alloy Castings* . . . A native of Wiota, Wis. (1904) . . . Earned his Bachelor of Science degree in metallurgy at University of Wisconsin, 1929 . . . Master



of Science degree in 1930, Ph.D. in 1931 . . . Assistant Professor at Michigan College of Mines, Houghton, Mich., 1931-1935 . . . Became affiliated with Aluminum Co. of America, Cleveland, in 1935 as Research Metallurgist . . . Vice President of Maryland Sanitary Mfg. Corp., Baltimore, 1942 . . . Now Assistant Supervisor at Battelle Memorial Institute, Columbus, Ohio . . . Has written extensively for the trade press and meetings of technical societies on physical metallurgy and non-ferrous foundry practices . . . Author of "Introduction to Metallography," published in 1931 . . . A member of A.F.A., A.I.M.E., A.S.M., and Institute of Metals (British).

Dr. H. A. Schwartz

Dr. Schwartz is the 1945 A.F.A. Foundation Lecturer, on *Solidification of Metals* . . . Abstract appears in this issue . . . A world-known authority on malleable iron . . . Born in Oldham County, Kentucky . . . Received his technical education at Rose Polytechnic Institute, Terre Haute, Ind. . . His degrees: B.S., 1901; M.S., 1903; M.E., 1905 . . . Recently honored by Rose Polytechnic with an Honorary Degree of Ph.D. . . In 1902 joined the National Malleable Castings Co., Indianapolis, starting out as a draftsman . . . Served successively as Chemist, Metallurgist, Assistant Superintendent . . . In 1920, became Director of Research for entire National Malleable & Steel Castings Co., Cleveland . . . Known to foundrymen everywhere for his many technical papers presented before meetings of numerous technical societies . . . Has contributed frequently to A.F.A. work . . . Awarded the John A. Penton Gold Medal of A.F.A. in 1930 . . . His work respected by foundrymen both here and abroad . . . Awarded E. J. Fox Gold Medal of Institute of British Foundrymen in 1939 . . . Member of A.F.A., A.S.M., A.I.M.E., A.S.T.M., S.A.E., and Iron and Steel Institute (British)

James A. Davis

See paper on *Reduction of Microporosity in Magnesium Alloy Castings*, authored by Mr. Davis and associates, J. C. DeHaven and L. W. Eastwood . . . Born in Ada, Ohio, and received his early schooling in Colorado . . . A graduate of Colorado School of Mines in 1939 . . . Metallurgist with Colorado Fuel & Iron Co., Pueblo, Colo., until 1943 . . . Now on Engineering Staff of Battelle Memorial Institute, Columbus, Ohio . . . Member of A.S.M.



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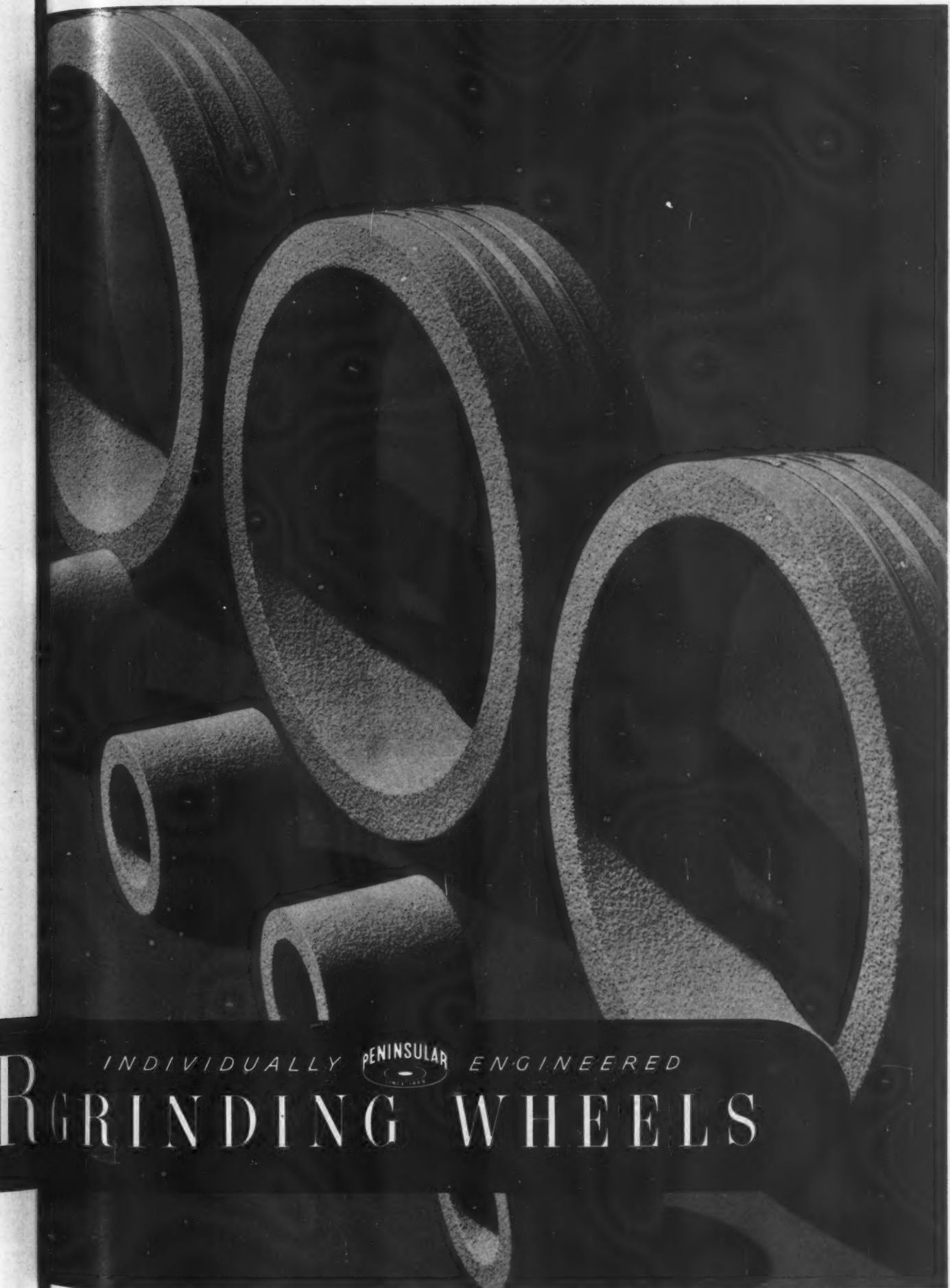
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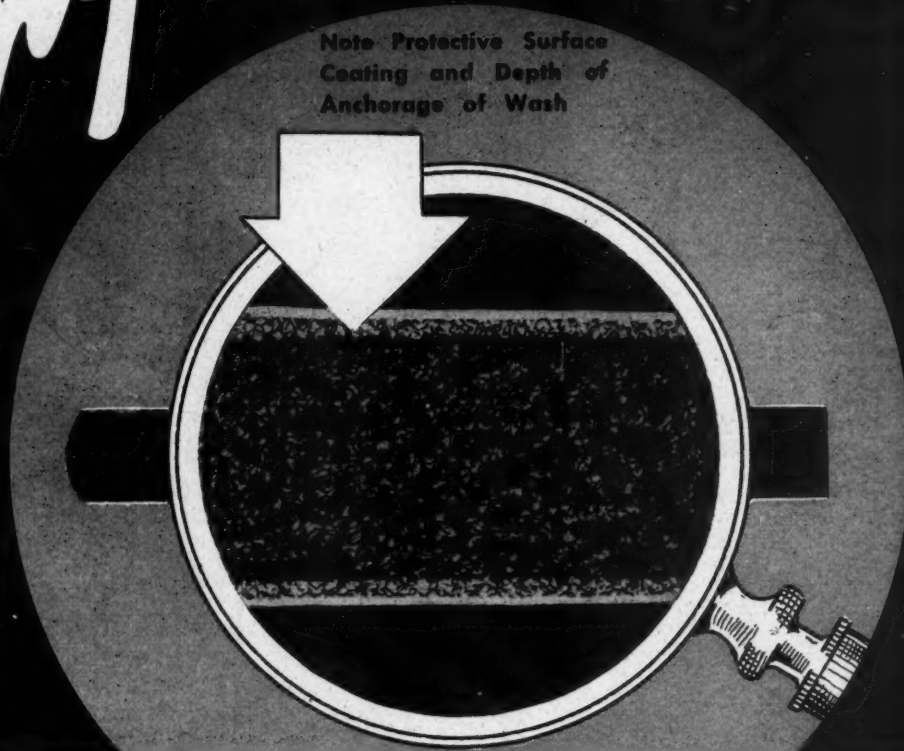
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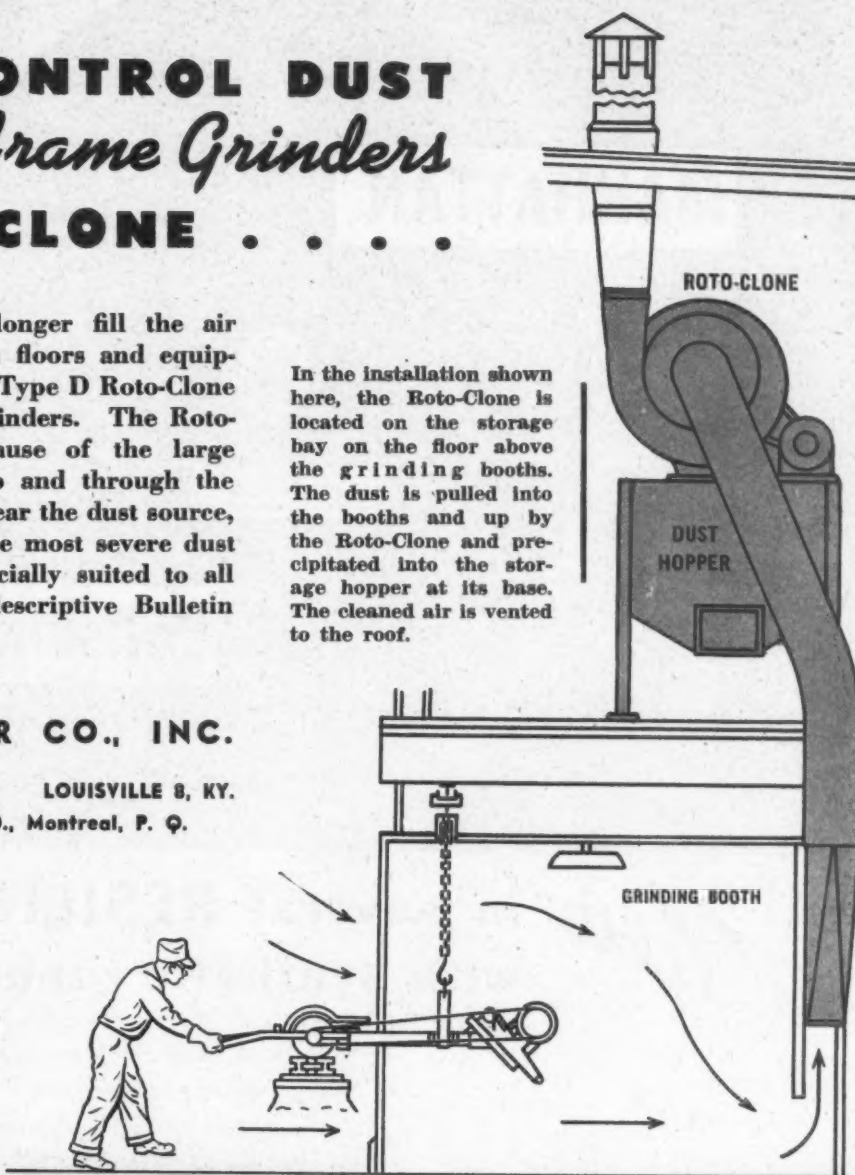
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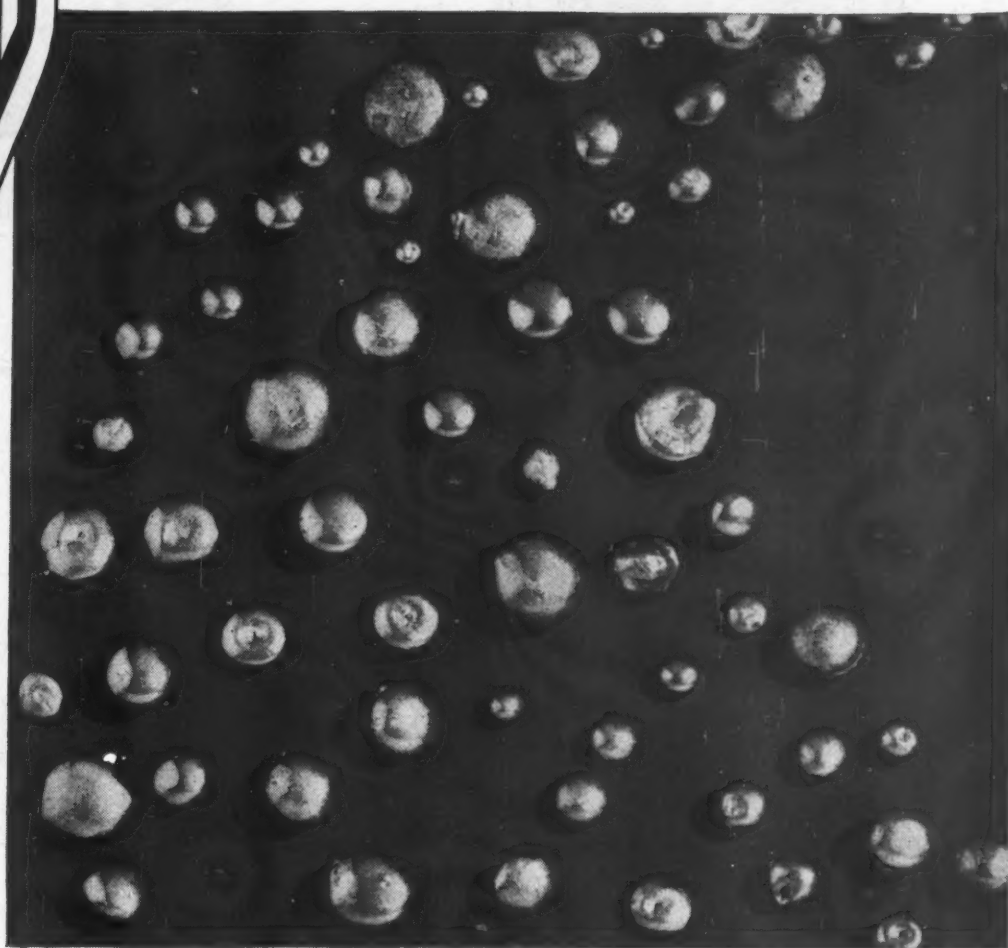
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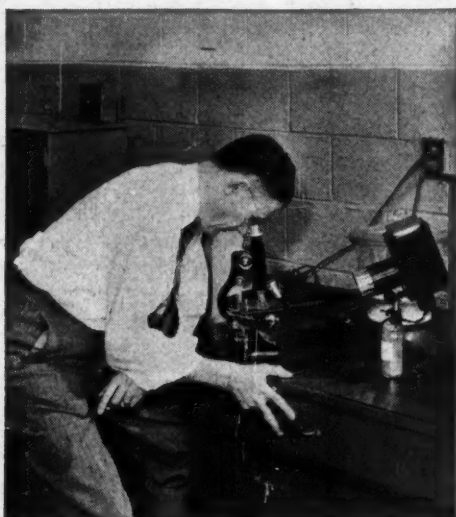
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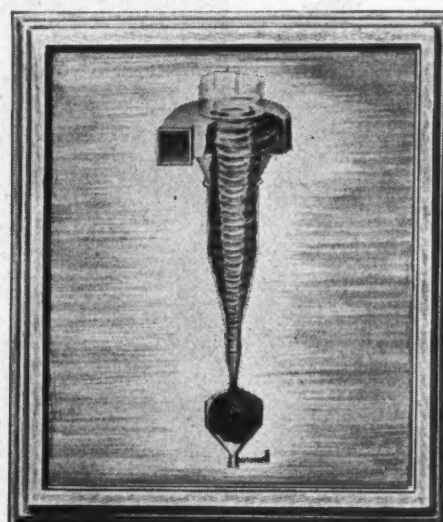
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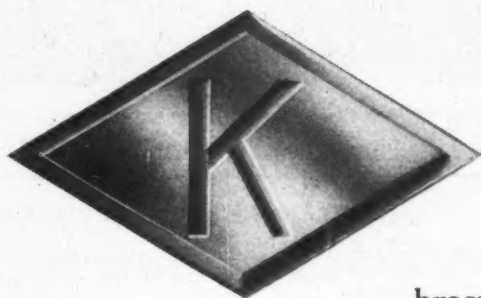
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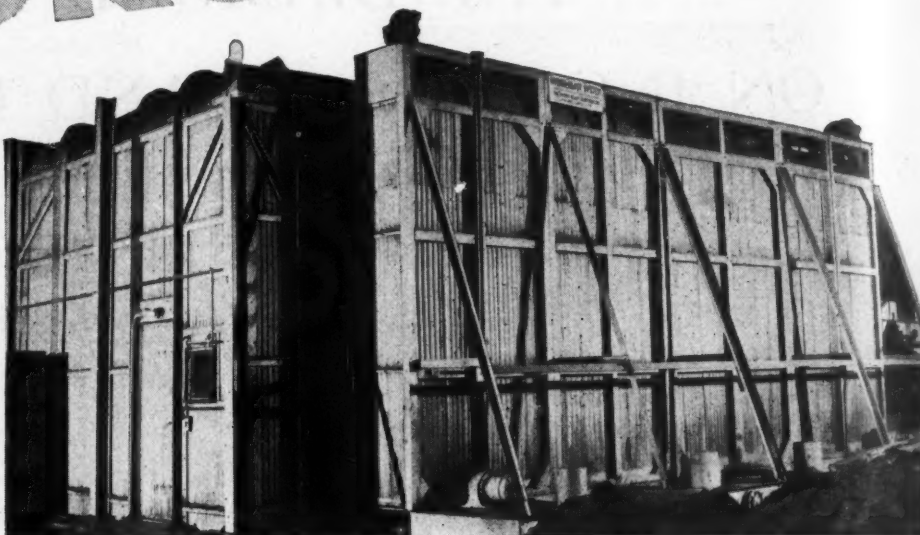


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The 2-gun Hydro-Blast at Erie Forge Company, Erie, Penna., is more than exceeding the most optimistic hopes of the management of this prominent steel foundry.

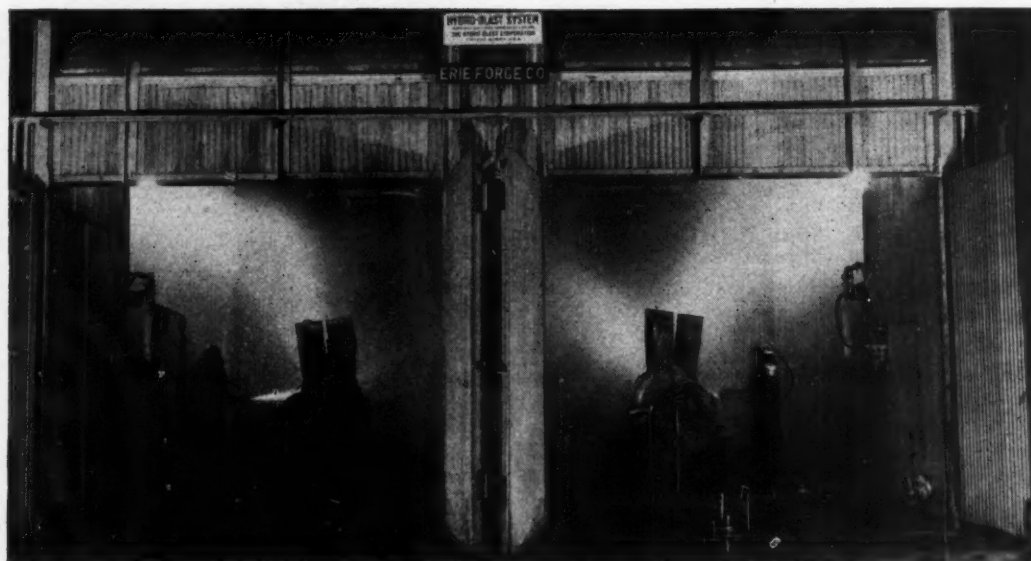
IMPORTANT ANNOUNCEMENT!

Due to a confusion in publication dates, the Hydro-Blast Name Contest has been extended to June 20 in fairness to all competitors.

Correction of Rule 7—

If a suggestion does not win a prize but is used later, a prize equal to the first prize will be awarded.

The date of the announcement of the winners cannot be set at this time.

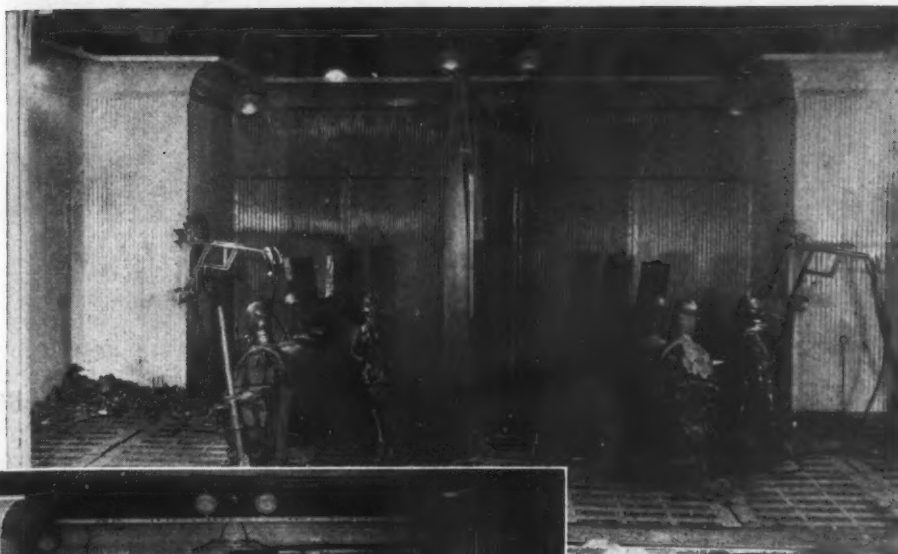


Rear view of Hydro-Blast room at Erie Forge showing 2-gun cleaning operation.

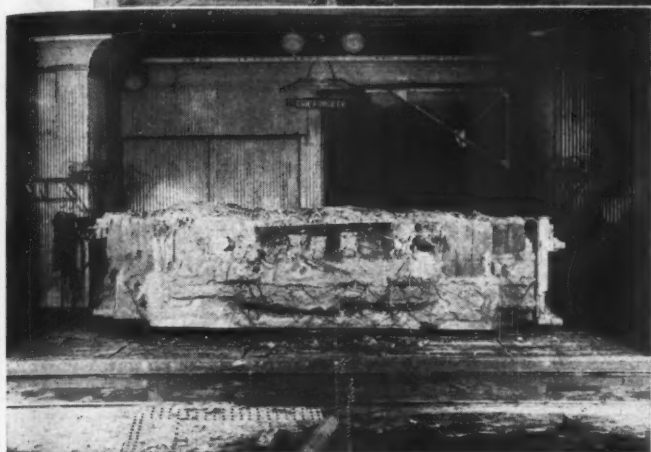
2550 N. WESTERN AVE.

HYDRO-

AMERICAN FOUNDRYMAN



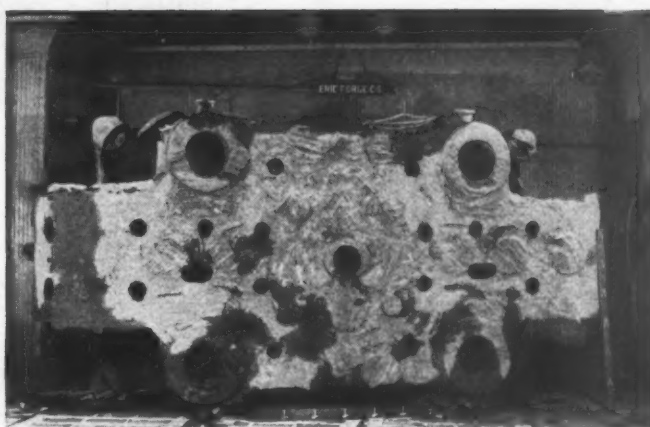
Front view of Hydro-Blast room at Erie Forge showing 2-gun cleaning operation.



View of castings in Hydro-Blast room at Erie Forge before Hydro-Blasting.

Men Are Important Too

The management of the Erie Forge Company considers not only the technical and economical aspects of making castings, but also the working conditions which encourage the best effort from their employees. Known throughout the world as producers of large and intricate steel castings, the Company shows an exceptionally low absentee record because it is always endeavoring to improve working conditions.



Another larger steel casting to be cleaned by the Hydro-Blast method of wet sand and water velocity.

The installation of Hydro-Blast represented another effort to make the Erie Forge foundry a more satisfactory and attractive place to work. This new method eliminates the dusty, noisy operations of core knock-out and surface cleaning through the suppression of dust at its source and the disposal of used sand.

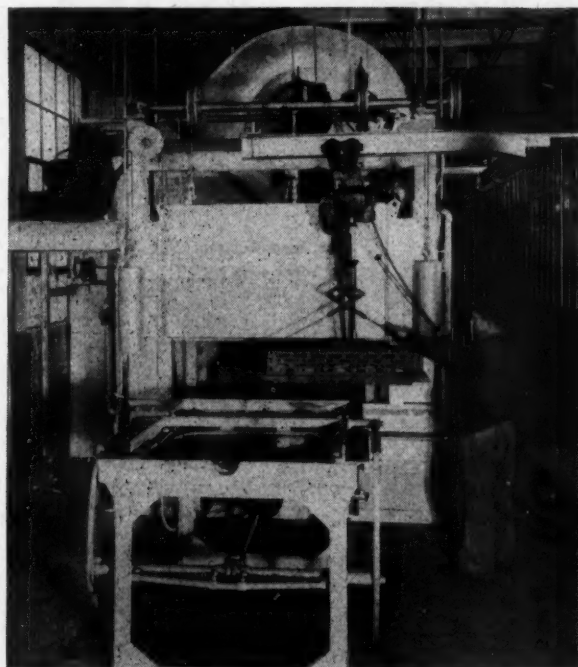
BLAST

CHICAGO 48, ILLINOIS



.... with a

- INCREASES MACHINABILITY OF CASTINGS
- CUTS RETOOLING COSTS
- SAVES MANHOURS DURING MACHINING OPERATIONS
- EXTENDS LIFE OF DRILLS, BROACHES, LATHE TOOLS, ETC.



ABOVE: Loading a tray of castings into the furnace. Tray size is 17" x 36" x 6". Furnace accommodates 38 trays. As one tray enters, one is pushed out at unloading end of furnace.

BELOW: The discharge end of the Maehler heat treating furnace at Chambers, Bering, Quinlan. Unloading device is completely automatic... returns empty trays to loading position.

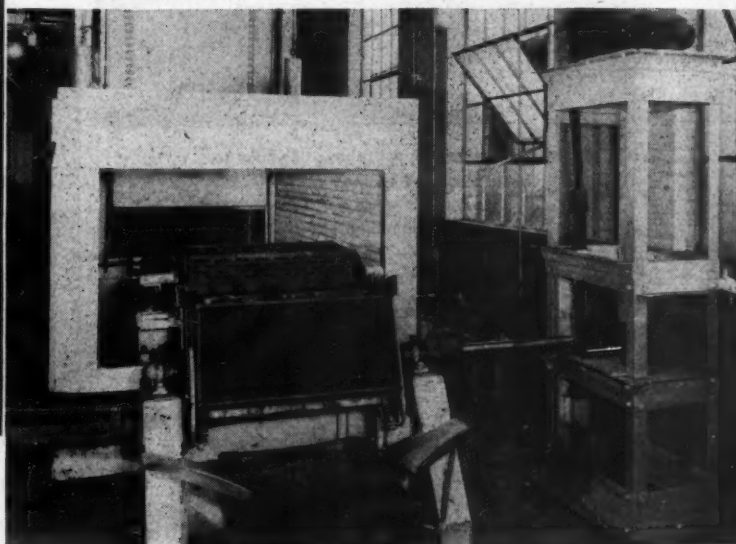
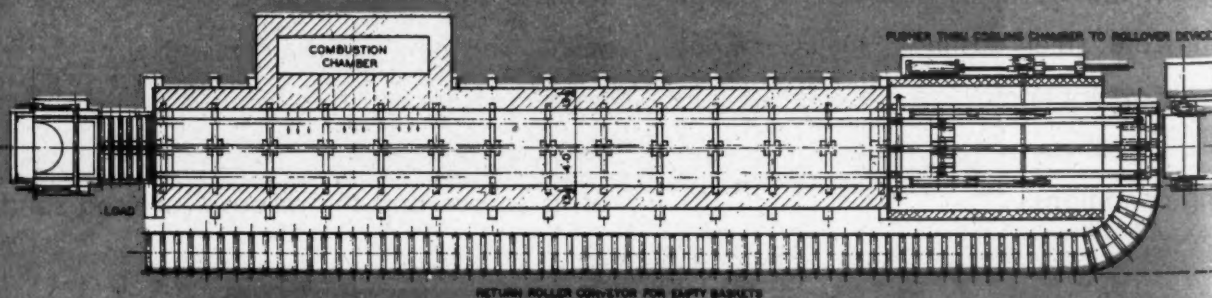


Diagram showing floor plan of the Maehler Heat Treating Furnace shown above. Note the return roller conveyor for empty baskets.



air-draw furnace

GRAY IRON CASTINGS

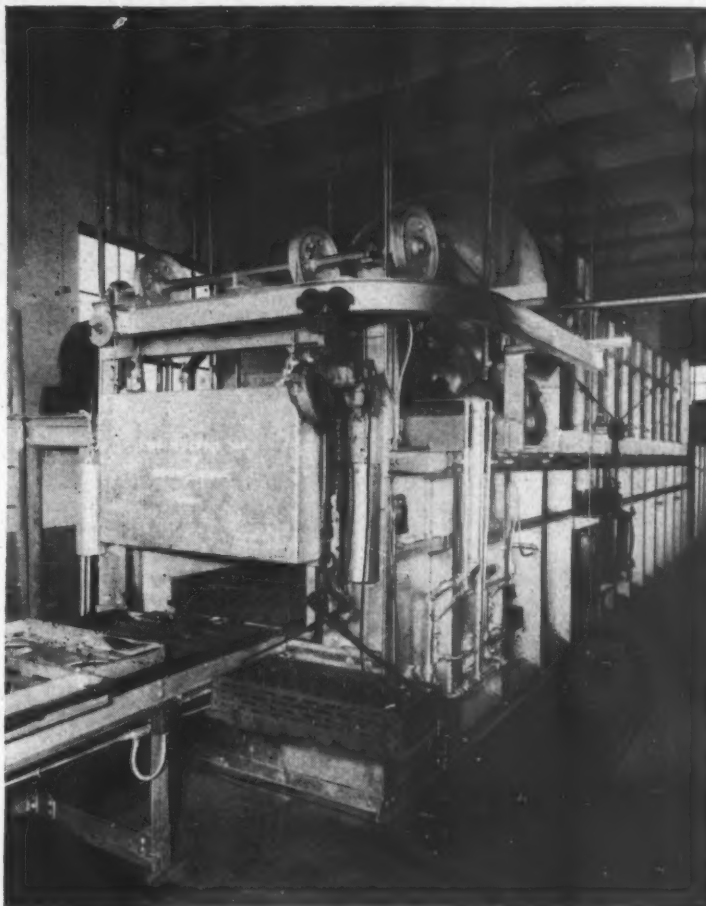
...are tough on tools such as drills, broaches, lathe tools, etc. By "soaking" this type of casting in temperatures around 1200°F. and *controlling the cooling*, the grain structure is refined to a degree which results in considerably less breakage of tools and a reduction in manhours during machining operations.

When the Chambers, Bering, Quinlan foundry in Decatur, Illinois, decided to anneal its gray iron castings, Maehler engineers were called in. The result was the installation of the efficient unit shown on these pages.

DATA and SPECIFICATIONS

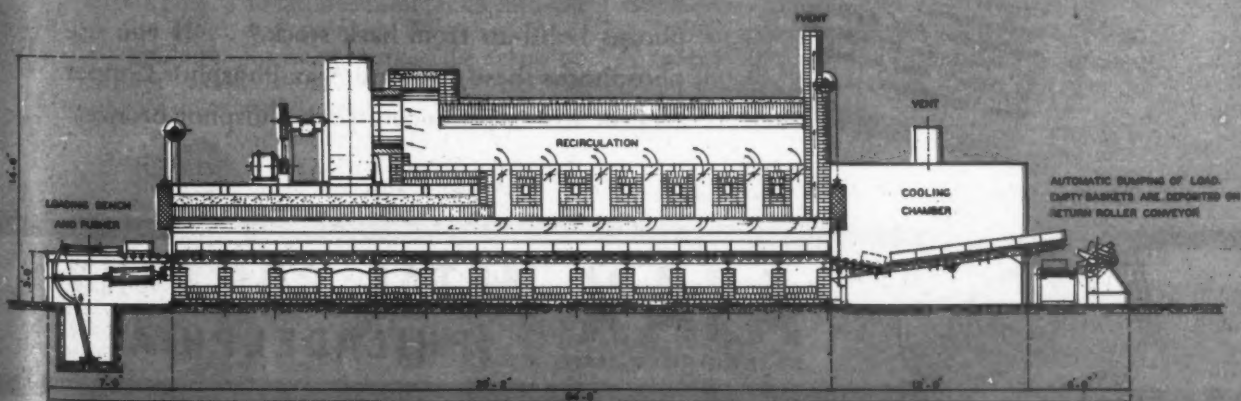
- Roller Conveyor Type Air-Draw Furnace.
- Gas-Fired—designed to operate at from 800°F to 1550° F.
- Capacity of Furnace—2,000 lbs. of castings per hour.
- Temperature variation—not over 2° F.
- Working space of furnace—4 ft. wide by 3 ft. 2 in. high by 36 ft. 6 in. long.
- Over-all length including 7 ft. 6 in. pusher loading station and a 12 ft. cooling chamber—57 ft. 6 in.
- Electric robot control panel completely supervises furnace operation.
- Garden City high-temperature fan driven by a 25 hp-2-speed motor circulates air at high velocity above normal furnace pressure.
- Soaking time of gray iron castings—1.45 hours at 1200° F.

You can save your customers manhours and tools and speed their machining operations when you furnish them *Maehler-annealed* castings. Call a Maehler engineer today . . . he is ready to work with you in designing a complete heat treating system. There is no obligation. The Paul Maehler Company, 2218 W. Lake Street, Chicago 22, Illinois.



MAEHLER

Industrial Ovens and Furnaces for
Core Baking, Mold Drying, Heat
Treating, Enameling, etc.



Lengthwise sectional diagram showing air distribution and loading and unloading devices of the Mashler Roller Conveyor Type Air-Draw Furnace at Chambers, Baring, Quinlan.



THE USE OF AJAX PHOSPHOR-COPPER

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Ajax Nickel-Copper 50-50%
Ajax Manganese Copper
Ajax Aluminum Alloys
Ajax Phosphor Copper
Ajax Silicon Copper
Ajax Nickel Alloys
Ajax Phosphor Tin

NOTE

"Proper Melting Decreases Foundry Losses," contains interesting data. Also, the booklet, "Nonferrous Ingot Metals of Today." Write for both of these. They are free.

Successful foundrymen deoxidize or "clean up" molten metal by a scientific method worth using as indicated:

They use phosphorus . . expertly . . in the form of "Ajax Phosphor Copper" . . added as the crucible is removed from the furnace . . for virtually all brass and bronze alloys.

In notched waffle sections, or in shot form, Ajax 15% P-Cu does its work at .01% (1 oz. per 100 lbs.). Introduced, and having time to react when stirred with a whirling motion of the skimmer, it causes oxides to rise for effective removal by skimming from the surface. It is best to avoid phosphorus build-up from back stock.* . . If you use phosphorus these days, use Ajax Phosphor Copper (useful also in producing your phosphor bronze)



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FASTER, EASIER WITH CLEVELAND TRAMRAIL

If you are thinking about tomorrow, you are giving serious thought to various ways of improving your foundry efficiency, speeding production and cutting costs. You will find Cleveland Tramrail of profound interest because, for the cost involved, there perhaps is no other important foundry equipment that will yield as profitable returns.

Pouring is just one example. Metal is tapped into a ladle on a tramrail carrier at the cupola. The ladle is then taken directly to the mold and poured. No rehandling. No spillage. No hard work. The crane or carrier rides freely and easily on the smooth overhead track.

Cleveland Tramrail equipment permits taking the ladle over the shortest route from cupola to mold without hindrance from floor obstacles. The metal is delivered with minimum heat loss.

Likewise in the handling of cores, sand, molds and castings are important economies and advantages possible with Cleveland Tramrail. Hundreds of installations in small and large foundries attest to the soundness of the overhead method of materials handling.

Our sales engineers will be glad to survey your needs. Their ideas may spell the difference between profit and loss in the coming period.

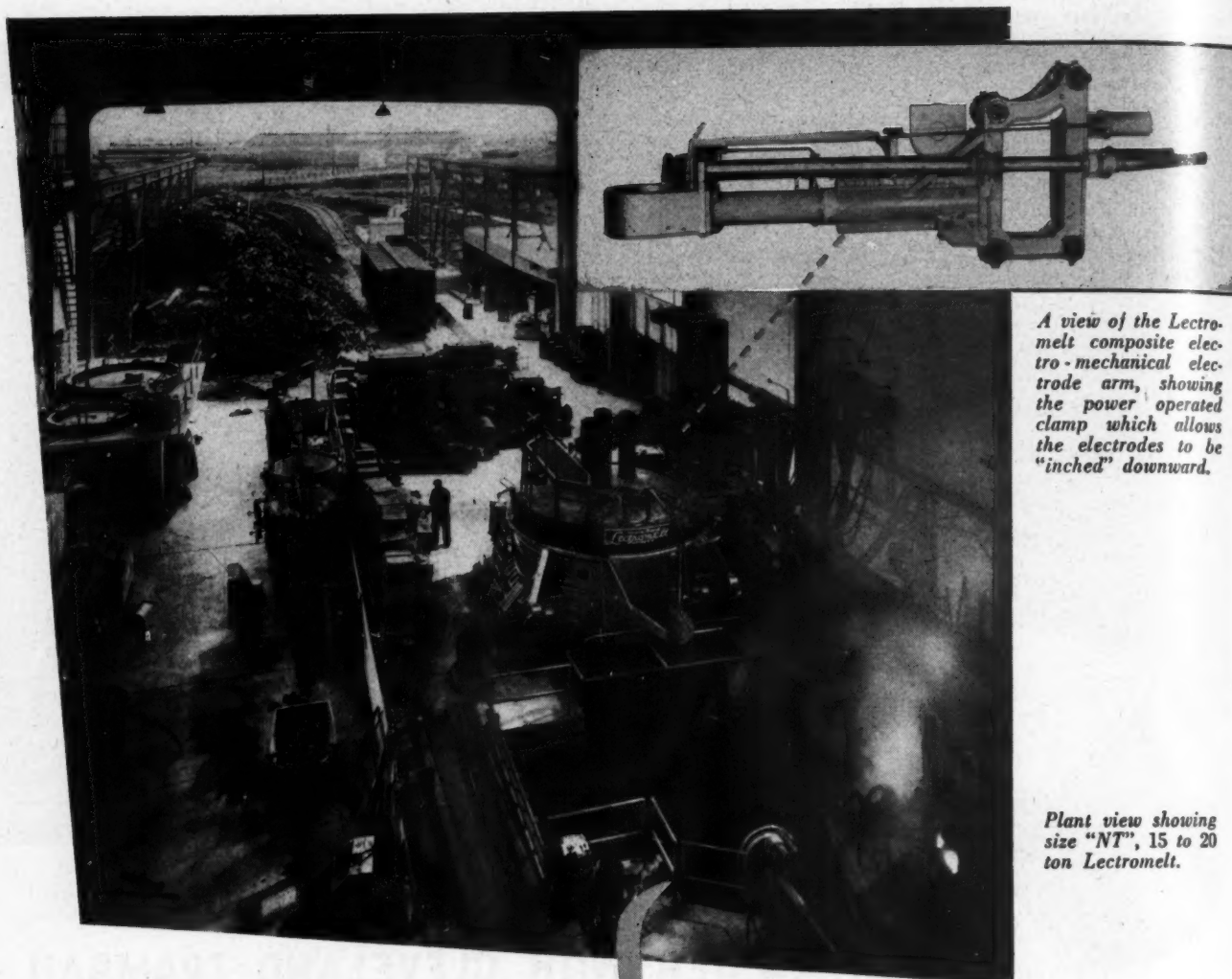
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THE CLEVELAND CRANE & ENGINEERING CO.
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A view of the Lectromelt composite electro-mechanical electrode arm, showing the power operated clamp which allows the electrodes to be "inched" downward.

Plant view showing size "NT", 15 to 20 ton Lectromelt.

MAXIMUM operating efficiency is assured with Lectromelt Furnaces, because of such features as the power operated clamp on the electro-mechanical electrode arm (Moore Patent). The pneumatic controls of the clamp enables the operator, without leaving the floor, to "inch" the electrodes downward when necessary.

This is not a new development with Lectromelt but has been thoroughly tested and in operation on some installations for years. It is an example of how the broad experience of the world's largest exclusive manufacturer of electric melting furnaces is incorporated in the design and construction of Lectromelt furnaces. Write for complete details.

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Quality Castings Through More Skilled Artisans in the Foundry

THE present world war brought into prominence the aluminum and magnesium foundry industries. Enormous demands were made on these industries for rapid increases in the production of castings to be used in the manufacture of aircraft. These castings had to be of the highest quality inasmuch as they were used in order to save as much weight as possible and designed to fill minimum safety factors.

Inspection and specification standards, that were set up for aircraft castings, seemed quite severe and many foundries complained. A number of foundries felt that the inspection routine—use of fixtures, X-ray, black light, and other procedures — was hampering production. The foundrymen found out, after working to these procedures, that they were learning how to produce more uniformly sound castings than they had ever produced before. Foundrymen began to find what causes defects and other objectional features in castings. In the meantime, all this improvement in quality was helping dispel the doubts that designing engineers had about uniform quality whenever they were considering the use of castings. The severe specification and inspection requirements proved to be a blessing in disguise.

The aluminum and magnesium foundry industries also were faced with the shortage of skilled foundry personnel. These industries, being comparatively young, did not have available a large number of men skilled in magnesium and aluminum foundry practice. There seemed to be a lack of young men interested in the foundry art. The men who were interested and remained in the foundry have done a heroic job.

However, more intelligent men, more far sighted men, that see possibilities in the foundry industry of the future are needed in the aluminum and magnesium industry, as well as the iron, steel and brass industries.

The A.F.A. slogan, "The foundry is a good place to work," is very true. No industry provides such wonderful opportunities to use a skilled man's artistry, ingenuity and originality. All foundries will require men of high caliber for the post war period and these men must be brought into the industry from our high schools and colleges. The modern foundry is not the gloomy, ill-ventilated place it was a few years ago, and modern foundries are good places to work.

The various branches of service have used our schools for intensive training in certain specialized fields. The answer to the foundry problem of trained men may be in the establishment of intensive foundry courses in our high schools, trade schools and universities. We believe that our educators are beginning to realize that such intensive courses are needed. The A.F.A. is doing its part to promote and induce many young men to enter the foundry industry. Only through more skilled workmen can uniform high quality castings be produced in the foundry.

LESLIE BROWN, Chairman,
A.F.A. Aluminum and Magnesium Division.

LESLIE BROWN, Plant Manager, Magnesium Fabricators Div., Bohn Aluminum and Brass Corp., Adrian, Mich., is chairman of the A.F.A. Aluminum and Magnesium Division. An active A.F.A. supporter, he has spoken before many chapters on the subject of magnesium foundry practice. Part of his experience in the foundry field includes work as head of a pattern shop in Detroit, and experimental engineer on magnesium for Dow Chemical Co.

• *Condensation of 1945 Foundation Lecture*

SOLIDIFICATION of METALS

By Dr. H. A. Schwartz, Manager of Research,
National Malleable & Steel Castings Co., Cleveland, Ohio

SINCE the foundryman must be concerned with the production of a piece of metal having a desired form, free from injurious voids and of a proper structure, by pouring liquid metal into a mold and allowing it to freeze, the subject of "Solidification of Metals" should be of fundamental interest.

The basic principles fall naturally into three fields: the crystallization of solids from the liquid state, the thermal properties of the materials involved, and the flow of heat through solids and liquids.

All metals solidify by building crystals. In this process atoms of metal in a liquid occasionally reach, by chance, such relative positions as they occupy in the solid state. If the temperature condition is favorable, nuclei grow by adding layers of atoms in a perfectly regular arrangement until, finally, adjacent crystals meet and no liquid is left.

Equilibrium

Except for pure metals and eutectic alloys, freezing does not take place at a single temperature but over a range of temperatures, and the metal first frozen is, in general, purer than that which remains liquid longer. The laws covering equilibrium between two or more phases are quite adequately understood as the work of that greatest of American scientists, Josiah Willard Gibbs. Under commercial conditions, equilibrium is seldom attained and departures from the expected behavior may be encountered.

Among the physical properties, we are concerned primarily with density, specific heat, and thermal conductivity, all as functions of temperature, and with the heat given off or absorbed when a metal changes its state, for example, when it freezes or melts.

For the purpose of calculating



Dr. H. A. Schwartz

heat transfer, the density, specific heat, and thermal conductivity are frequently used in the form of a derived constant, "diffusivity," calculated from the three. One also must be interested in the properties of liquids which influence their flow, viscosity, and surface tension.

The fundamental principles of heat transfer were first systematized by the famous Napoleonic mathematician, Fourier. The basic assumption that heat flows across a given plane in a body at a rate proportional to the temperature gradient at that plane is childishly simple. Its mathematical application to the cooling of bodies is made by a process invented by Fourier for this purpose, and may become extraordinarily complicated. Various expedients, mathematical, graphical and electrical, have been devised to simplify the treatment.

The foundryman wishes to control solidification in such a way that "voids," no matter why they form, can be filled by a further supply of liquid metal. The fundamental principle is that solidification shall begin furthest away from the last remaining source of liquid and progressively approach that point. This

means that freezing shall take place toward the feeder, a process referred to as controlled or progressive solidification.

Unfortunately, one cannot furnish a rigid treatment of the subject from this practical viewpoint. However, it is possible to explain the scientific principles to be considered in securing the desired ends. In such a discussion, it is necessary to make simplifying approximations which clarify our understanding without making the conclusions inapplicable to actual cases.

In the published paper, the various principles to be considered are described in some detail and rather completely illustrated. Most of this detail and all the illustrations must be omitted and only the principal features described in this abstract.

Cooling Rate

The number of nuclei from which solidification takes place depends primarily upon the cooling rate through the melting point or melting range. Since each nucleus grows to a crystal, the grain size of the frozen metal is largely determined by this freezing rate. Rapid cooling makes for fine grain, and vice versa.

All crystalline substances have a property which is called "linear crystallization velocity." This represents the rate at which the solid substance can build layers of atoms upon its surface. Surprisingly enough, this velocity for a given substance is not greatly variable with temperature.

Since crystals can grow only at a rate fixed by this velocity, the rate at which heat can be given off when a metal freezes is not unlimited. It therefore is quite possible, by the use of metal molds or chills, to absorb heat so rapidly that the metal remains liquid below its normal melting point. The more it can be super-cooled, the greater the num-

AMERICAN FOUNDRYMAN

• This condensed version of the 1945 A.F.A. Foundation Lecture, although departing somewhat from the original text, is presented in this form to focus attention on the basic principles of metals solidification—heat transfer—so fully treated in the complete Lecture, which will be printed in pamphlet form and made available to A.F.A. members.

ber of nuclei which can survive and build a grain of the frozen metal.

Solidification Structures

During selective freezing, especially, solidification does not take place by the growth of simple geometrical shapes; instead, these crystallites grow in certain preferential directions, often forming dendritic or tree-like patterns. Such branching growths may entrap liquid metal within them which becomes entirely isolated from any further supply of liquid and leaves a shrinkage void of microscopic size, or a porous shrink, as the case may be, in the casting.

Metal very rapidly cooled at its surface often grows into columnar structures perpendicular to the surface of the casting, all the heat which is abstracted being supplied by the freezing of metal at the ends of these columns while the liquid metal remains sufficiently hot so that no nuclei are distributed throughout its mass. This process is facilitated if the thermal conductivity of the solid metal is much higher than that of the liquid.

Few commercial metals are not alloys of more than one element. The liquid always contains all of the elements present, and the solid usually contains more than one. Almost invariably, at any given temperature, the solid and liquid, if in equilibrium, are not of the same composition.

Solubility

There are but few cases where liquid metals are not soluble in each other in all proportions. In the solid state, solubility may be practically absent, it may be limited, or the solid elements may be soluble in each other in all proportions. The case of limited solubility is the most common.

Why solid solubility does, or does not exist, is related fundamentally

to the crystalline structure of the metals and to the architecture of atoms in terms of protons and electrons. One of the simplest of statements applicable in this field is that solubility can be unlimited only between elements whose atoms are within about 15 per cent of the same size, and whose crystal habit is the same. The matter is of little importance to the foundryman.

For practical purposes, the composition of the phases in equilibrium with one another at various temperatures is recorded on constitutional or equilibrium diagrams. If one knows the composition of the phases in equilibrium, their relative amounts can be calculated by simple arithmetic.

Physical Properties of Materials

In studying the physical properties of substances for use in connection with our major problem, we find them to fall into three groups. Those influencing the transfer of heat through the metal, through the mold material and between the metal and the mold; those which determine the changes of dimension accompanying changes of temperature and changes of state, and those properties of the liquid metal which determine its ability to flow into voids.

The constant of proportionality which determines how much heat will be conducted across a given plane of unit area for a given temperature gradient is called "the conductivity of the substance." It is an observational constant, differing with different substances, and changes with the temperature. It is sometimes convenient to know that the electrical resistance of a metal is, in general, closely related in theory to its thermal conductivity.

The amount of heat required to heat a unit mass of a substance 1°C . is called its "thermal capacity" or "specific heat." When heat is trans-

ferred into a body, the amount by which the temperature is raised depends upon the specific heat of the substance and its density. Since we are ordinarily concerned with the flow of heat to a given distance, this must be translated into the capacity per unit of volume.

"Diffusivity"

If we wish to associate the rate of heat flow with the change of temperature experienced by the body, we use an artificial physical concept called "diffusivity," which is calculated from the constants just referred to. Specific heats and densities are observational constants and change with temperature. Very symmetrically crystalline substances can have their specific heat calculated by a relation called the "Debye function."

Latent Heat of Fusion

Since we are dealing with the freezing processes, a most important thermal property of the metal for the foundryman is its latent heat of fusion. This represents the heat energy required to tear apart the bonds holding the atoms together in the crystal, without greatly altering the distance by which these atoms are separated.

There is a rule called "Trouton's," undeservedly much disregarded, which correlates the latent heat of fusion with the melting point of the substance. Although the rule is not accurate, it frequently permits useful estimates where actual knowledge is lacking. For the purposes of foundry physics, the specific heats of the components of an alloy usually can be taken as additive, although again this is not rigidly true.

The change in volume when a super-heated metal becomes a solid at room temperature is made up of three portions: the contraction of the liquid while cooling from its original temperature to the melting point, the change of volume accompanying the change of state, and the contraction of the solid on cooling to room temperature.

Coefficient of Thermal Expansion

All who have observed a mercury thermometer are aware that the amount by which a given amount of liquid metal expands for a given increase in temperature is approximately independent of the temperature. However, this coefficient of thermal expansion is different for

different substances. Most metals contract in the process of freezing. "Type metal" expands, as does high carbon gray iron.

The coefficient of thermal expansion of a solid varies with the temperature and, for a given metal, is proportional to its specific heat, regardless of temperature. This principle is sometimes of use in obtaining one of its properties if the other is known.

When alloys freeze selectively, the change of volume during freezing takes place over a temperature interval. The change of volume of cast iron has been very thoroughly studied at the National Bureau of Standards under the auspices of this Association.

The writer has had occasion to observe that spheres cast experimentally from various white cast irons have the same apparent density, whether they show evidence of gross internal shrinkage or not. The explanation is merely that if the shrinkage does not all go to one place, an equal volume is distributed finally throughout the entire mass and is no longer detectable.

Metal Flow

The foundryman's consideration of the "*Solidification of Metals*" must lead to the flow of metal from the feeder into the voids, be these large cavities or microscopic fissures. One must, therefore, have some understanding of the laws governing the flow of liquid in pipes or channels.

The surface layer of metal in contact with the solid wall probably does not move forward at all. The layers further in move forward, each with a higher velocity than its outside neighbor. The metal thus advances by a process resembling its turning itself inside out continually. The property of the metal which resists such flow is called "viscosity."

The calculation of the rate of flow of liquid of known viscosity in simple pipes or channels is well understood. The foundryman judges this property by pouring a special casting called a "fluidity spiral," and determining how far down this spiral the metal will flow under a given head. This method is exceedingly useful, although it does not actually measure viscosity, but includes other variables.

There is a limit to the size of passage into which a liquid will flow. Because of the unbalance of forces on the atoms at the surface of a liquid, the latter behaves as though it were surrounded by an elastic skin. This is a property called "surface tension," which can be measured. It depends upon the substance, the temperature, and very greatly upon the presence of impurities.

Surface Tension

However, for any given surface tension and pressure there is a passage so small that the metal cannot enter because the surface tension forces hold it back. This is quite fortunate because if there were no surface tension, the metal would not stay in the mold but would permeate deeply between the sand grains.

It is, of course, necessary that there must be some sort of a pressure head to cause liquid metal to flow through a narrow passage. This means that there must be some way of having atmospheric pressure reach the surface of the liquid metal in a feeder, or the layer cannot supply liquid.

Since many metals, on freezing, evolve gases which enter the shrinkage cavities, counterpressure which actually forces the last freezing metal out from the interdendritic spaces may be set up. There is, therefore, a necessity for studying solubility of gases in liquid and solid metals.

Some metals, on freezing, reject solid non-metallic impurities which interrupt the continuity of the metal and have an effect equivalent to voids of similar shape and size. If its sonims form while the metal is entirely liquid, they try to float upward at rates depending on their size, the difference in density of the metal and sonims, and the viscosity of the liquid.

Progressive Feeding

In the early stages of freezing, the solid shell is quite plastic and may be expanded by internal pressure, with a corresponding effect on the amount of shrinkage void to be filled.

Data have been gathered on the contraction of steel freezing under restraint, which furnish a basis for exploring this subject. The progres-

sive freezing desired by the foundryman can be had only if the rate of heat transfer from the liquid to the solid is such as to produce the first freezing in those regions most distant from the feeder. It therefore becomes necessary to consider the entire subject of heat flow.

An enormous amount of work has been done on this subject which cannot be even outlined under the circumstances of this abstract. In the full text of the paper some pertinent examples have been discussed.

It is of some interest to know what will be the shape and location of the void which is left when metal freezes. In the case of a cylindrical casting losing heat only from the outside surface, a pipe will extend as a thin thread clear to the bottom of the casting. If the casting cools from the bottom also, or if it is conical instead of cylindrical, or if it is poured slowly enough to establish temperature gradients, other forms of shrinkage voids will be established.

Application of Principles

Mathematical studies of the freezing of simple shapes have shown that whether the casting will show an internal shrinkage void, or a "sink" at the top, is a function of the degree of super heat of the liquid metal. This is a point of possible importance to the foundryman.

If the writer has been at all successful in his purpose, it will now be clear that most of the problems connected with the solidification of metals, both in the abstract and in the sense of making solid castings, can be solved by the application of the classic principles of physics.

The existing difficulties arise out of experimental handicaps in determining some of the constants involved, and out of the mathematical difficulty incident to obtaining solutions of the equations corresponding to the rather complex shapes and conditions with which the foundryman is concerned.

It was pointed out by Bolton in the first Foundation Lecture ("*Foundry Metallurgy*," 1943), that foundries have availed themselves of mechanization to a truly remarkable extent. This is, in part, perhaps due to the fact that the mechanical devices were constructed by people who wanted to sell something to the

foundries, and brought to us approximately finished plans by which it was expected that money could be saved.

Physicist in the Foundry

In "*Foundry Metallurgy*" it was also pointed out by Bolton that very considerable progress was made, but not within the industry. This branch of science has been used mainly in connection with the control of the properties of the metal and, to some extent, with improvements in melting and heat treatment.

What is really the most fundamental problem in the foundry industry, the making of castings, has been almost neglected. Only in the field of the properties of molding sand has technology been thoroughly applied to improve the molder's craftsmanship. If foundries are to come out of the dirt and become places for the practice of engineering skill, then this most important field can no longer be neglected. Perhaps the present paper has suggested the direction in which the foundryman might look to the physicist for help.

On the other hand, it is unfortunately true that the physicist has been almost entirely neglectful of the extent to which his science could be used in the making of castings. At the moment the writer is able to think of but one trained physicist who became a foundryman.

Technology vs. Craftsmanship

In our struggle to substitute technology for craftsmanship, it will be necessary to attract the attention of those who have specialized somewhat in mathematics and physics. So far we proceed by rule of thought. The physicist could help us proceed along scientific lines. Unfortunately, the physicists have largely directed their attention away from such problems as interest us.

In 1893 the illustrious von Helmholtz, speaking at Chicago, said that there were no new principles to be discovered in physics, and the only remaining fields were in the direction of greater precision of knowledge. Two years later Roentgen discovered the X-ray, and the science of physics has never been the same since that time.

The impact of Roentgen's discov-

ery on the study of radiation and the structure of matter was so great that apparently the higher qualified physicist could not longer interest himself in the more mundane fields. The physicist interested in the application of electricity has generally found an outlet for his energies in electrical engineering, but the physicist interested in heat problems does not seem to have been aware of the enormous practical field awaiting his efforts in the foundry.

Addressing the International Foundry Congress in London in 1939, Sir W. Lawrence Bragg, Cavendish Professor of Physics at Cambridge University, England, made

the statement that what industry needs is a group of people who can interpret the findings of the pure scientist for the benefit of industry. The author has attempted here to contribute his modest efforts along the lines suggested by Professor Bragg.

If some physicist can be persuaded to deal with the problems of heat conduction under the circumstances that interest the foundryman—if our engineers can take these facts and translate them into operating principles, then our foundries will be able to make, systematically and continuously, and without so much "cut and try," superior castings.

FRENCH FOUNDRY GROUP Revives Annual Meetings This Year

THE annual meetings of the French Foundry Technical Association, discontinued when the war in Europe began in 1939, are to be resumed this October, according to word from France. In a letter dated March 9 from Pierre Chevenard, president of the Association Technique de Fonderie de France, the French association, a cordial invitation was extended members of A.F.A. to attend the meeting which is to be known as "Foundry Days."

At the same time, Mr. Chevenard expressed the hope that the exchange paper arrangement which existed for so many years between

establishing a bond of international foundry good will that dates back to World War I.

The French Foundry Technical Association was one of several foreign foundry groups of which A.F.A. has been affiliated on the International Committee of Foundry Technical Associations. All A.F.A. members who had contact with foundrymen on the continent before the war will be glad to see that the French group is losing no time in building again toward an important place in international circles.

Dates Back to 1919

The history of international relations between the American and European foundry industries is unique, started in 1919 by a president of A.F.A., the late A. O. Backert, then president of Penton Publishing Co., Cleveland. On a visit to England in that year, Mr. Backert extended an invitation to British foundrymen to attend the 1919 convention and exhibit of A.F.A. in Philadelphia.

A number of foreign foundrymen came to the U.S. for the meeting, and the first official exchange paper of A.F.A. was presented to the Institute of British Foundrymen the following year. Exchange of papers between the two societies has been carried on ever since without interruption, and today is the longest



J. S. Vanick

A.F.A. and his group might be resumed this year. As a result, J. S. Vanick, metallurgist for International Nickel Co., New York, has agreed to prepare a paper on "Developments in Foundry Practice" in this country during the war years. His paper will be forwarded in time for the October meeting, thus re-

and most continuous exchange paper arrangement between any two countries in the world.

Similar exchange arrangements have been carried on periodically between A.F.A. and the French, Belgian and Italian foundry associations. More recently, papers have been exchanged with the Australian Foundry Association as well.

The idea of staging an international foundry congress was first broached in 1922 and the first such event was held in Paris in 1923. Establishment of the International Committee of Foundry Technical Associations followed in 1925, on which the A.F.A. has been continuously represented.

U. S. International Overdue

Two Internationals have been held in this country thus far, one in Detroit in 1926, the other in Philadelphia in 1934. A third, scheduled for Cleveland in 1942 in accordance with the accepted 8-year interval, was canceled because of the war. It now is hoped that the 50th Anniversary convention of the Association may be held in 1946, as America's third International Foundry Congress.

Professor Chevenard, one of the most widely known French foundry-

men, participated in the 1923 Paris International and has long been a dominant figure in Continental foundry group activities. He has authored numerous papers presented before meetings of technical and scientific organizations of Europe.

Delpont Represents A.F.A.

For many years A.F.A. has been represented in Europe by Vincent Delpont, Penton Publishing Co., Ltd., London, at the Internationals held abroad and at meetings of the various foreign foundry groups. A past-chairman of the International committee, Mr. Delpont was awarded the gold medal of the French Foundry Technical Association in 1939 for his activities in promoting good will and better relations between the foundry groups of different countries.

With the possibility of an American International next year, the A.F.A. Committee on International Relations takes on new importance, under the chairmanship of Frank G. Steinebach, *The Foundry*, Cleveland. Other representatives on the committee are: *Europe*—Mr. Delpont; *Brazil*—Miguel Siegel, Instituto de Pesquisas Tecnologicas, Sao Paulo; *Australia*—Wm. A. Gibson, Sydney.

AFA To Hold Its Annual Business Meeting July 18

IN LIEU of an industry-wide convention, A.F.A. will hold its Annual Business Meeting on July 18 at the Palmer House, Chicago, with attendance on a representative basis. Delegates to the 2nd Annual Chapter Chairman Conference on July 17-18 are expected to attend, representing the membership at large, as well as a number of National A.F.A. Directors, who will convene July 19-20 for the Annual Board Meeting.

A feature of the July 18 meeting will be the honoring of several outstanding men of the Industry. Gold medal awards will be made to A.F.A. Secretary R. E. Kennedy, and to C. E. Sims, Battelle Memorial Institute, Columbus, Ohio.

Honorary Life memberships will be presented to Rear Admiral A. H. Van Keuren, U.S.N., director of Naval Research Laboratory, Washington, D. C.; to M. J. Gregory, retired, a past Director of A.F.A.; to R. E. Kennedy and C. E. Sims; and to retiring A.F.A. President R. J. Teetor, Cadillac Malleable Iron Co., Cadillac, Mich.

At the dinner meeting, special recognition will be given the 1945 A.F.A. Foundation Lecturer, H. A. Schwartz.



When Ensign Harry R. Dahlberg, USNR, visited London earlier this year, he quickly became acquainted with several outstanding British foundrymen and was the guest of V. C. Faulkner, Editor of "Foundry Trade Journal" and a past-president of the Institute of British Foundrymen. This London picture shows (left to right) J. K. Smithson, North Eastern Iron Refining Co., Secretary, Middlesbrough branch, I.B.F.; R. B. Templeton, Ealing Park Foundry Co., London, past-president, London branch, I.B.F.; John Bolton, Acting Secretary, I.B.F.; Thomas Makemson, Director of Iron Castings, Ministry of Supply, Secretary, I.B.F.; V. C. Faulkner; Ensign Dahlberg, former chairman of the University of Minnesota Student Chapter of A.F.A., and winner of the 1943 A.F.A. Student Essay Contest.

Non-Ferrous Founders Elect Horlebein President

AT the Non-Ferrous Founders' Society's annual meeting held in Detroit, Mich., recently, Edwin W. Horlebein, president, The Gibson & Kirk Co., Baltimore, Md., was elected president of that society. Mr. Horlebein, a past chairman of the A.F.A. Chesapeake chapter and at present a director of that chapter, has been nominated to serve as a member of the National A.F.A. Board of Directors.

Thomas S. Hemenway, head of Metal & Alloy Specialties Co., Inc., Buffalo, N. Y., was elected to the vice-presidency.

Retiring president of the society is Roy M. Jacobs, Standard Brass Works, Milwaukee, Wis., a national director of A.F.A. and a past chairman of the A.F.A. Wisconsin chapter.

AMERICAN FOUNDRYMAN

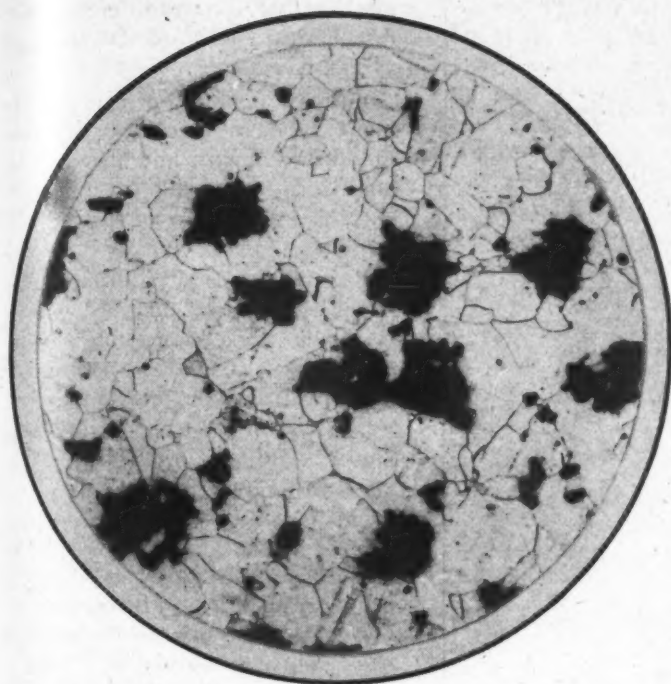


Plate I—Photomicrograph showing ferrite and temper carbon structure of normally annealed malleable cast iron. Unetched.

• The particular product dealt with in this discussion is malleable iron castings. The control processes deal with melting the cold charge in powdered coal fired reverberatory furnaces and annealing the castings in periodic ovens. Many of the control principles discussed could be applied to other melting and annealing processes.

MALLEABLE IRON CONTROL

By M. E. McKinney,
Chief Metallurgist, International Harvester Co.,
Hamilton, Ont., Canada

THE control of manufacturing processes is an interesting and attractive study, probably because therein perfection is attempted but never attained. There always remains this or that variable from which, although it might be controlled, the added benefits are not worth the expense entailed. Usually, however, if a few of the most dangerous variables are controlled the sum total of the remainder will not cause the finished product to vary outside those limits necessary and acceptable in a good commercial product.

Control in General

The object of control in malleable castings is to turn out a product which will give entire satisfaction both in subsequent manufacturing operations and in service. As it is extremely difficult to apply any suitable test to numerous different shapes and sizes of castings, quality of the metal itself usually is based on a test bar, the physical properties of which have been set by most of the leading metallurgical and mechanical societies.

Complaints from the shop and from the field of service usually are caused by that part of the product which falls below standards in physical properties. The questionable

advantages of any part of the product which is above standards can never offset the complaints caused by that part below standards. The object of control is to eliminate that part of the product which falls below standards.

Before attempting control one must be aware of all the variables which might affect quality. One must also have a fair knowledge of their relative importance. Control then should be started on those variables of greatest importance, and continued until that part of the product falling below standards has been eliminated. The value of any further control is doubtful unless, of course, some reduction in cost is accomplished which will pay for the added control.

Malleable casting production can be divided into three main headings; raw materials and mixtures, melting practice, and annealing. Control must be applied to each of these three.

Now control to some people means an apparatus of some kind, usually automatic, which when attached to a furnace or oven immediately becomes a panacea for all ills, and from thence on all troubles cease. Such persons are doomed to quite rapid disappointment.

Some methods of control are much more complicated than an automatic apparatus, but the greater part are really much simpler. A large part of control entails no apparatus at all, but simply the application of some rule or habit of good sense and order.

Psychological Factors

Psychology plays a very important role in control, especially where some piece of apparatus must be put into the hands of an already experienced and reasonably successful operator. A few of the psychological factors are as follows:

Let the operator know that he is being provided with a new tool which he will not be able to use until he has mastered its principles.

Let him know that any Tom, Dick or Harry would not have the furnace knowledge necessary to learn how to use it and appreciate its advantages.

Let him know that when he has learned how to use it he will be still more experienced than he now is, and that if he can master it his work will become manually easier.

It is always an advantage to have the commendation and

Table 1
MELTING LOSSES

Date	Silicon Loss*, Per Cent				Carbon Loss*, Per Cent			
	Before		After		Before		After	
	Prelim. Analysis (1)	(2)	Prelim. Analysis (3)	(4)	Prelim. Analysis (5)	(6)	Prelim. Analysis (7)	(8)
Nov., 1943	5-Day		5-Day		5-Day		5-Day	
1	Daily		Daily		Daily		Daily	
2	(0.49)	.....	(0.13)	.....	(0.47)	.....	0.20	.....
3	0.27	.....	(0.09)	.....	0.29	.....	0.24	.....
4	0.29	.....	0.03+	.....	0.34	.....	(0.27)	.....
5	(0.39)	.....	0.04+	.....	(0.39)	.....	0.14	.....
6	(0.30)	.....	0.00	.....	(0.36)	.....	0.18	.....
7	0.18	0.286	0.01+	0.002	0.23	0.322	0.24	0.200
8	0.24	0.256	(0.06)	0.004+	0.33	0.310	(0.26)	0.212
9	0.25	0.252	0.02	0.012+	(0.33)	0.318	0.23	0.210
10	(0.29)	0.252	0.03+	0.012+	0.29	0.308	0.25	0.208
11	0.27	0.246	0.04+	0.012+	0.25	0.286	(0.28)	0.232
12	0.28	0.244	0.00	0.012+	0.26	0.272	0.24	0.244

*Plus marks indicate a gain instead of a loss.

Table 2
LOSS CALCULATION

Date: Nov. 12, 1943.	Heat No. 1, Furnace No. 1	
	Per Cent	Per Cent
	Si	C
Calculated Analysis	1.25	3.00
Preliminary Analysis	0.97	2.74
Loss Before Preliminary	0.28	0.26
Preliminary Analysis	0.97	2.74
Added Elements	0.05	0.00
Rectified Preliminary	1.02	2.74
Final Analysis	1.02	2.50
Loss After Preliminary	0.00	0.24
Avg. Loss Before Preliminary	0.244	0.272
Avg. Loss After Preliminary	0.012	0.244
Avg. Total Loss After Preliminary	0.232	0.516
Desired Final Analysis	1.000	2.500
Required Calculated Analysis	1.232	3.016

praise of the apparatus come first from the operator himself.

Do not create the impression that with this apparatus his experience and skill are no longer necessary.

Do not create the impression that from now on, any Tom, Dick or Harry can operate the furnace, and the results will be even better than before.

Do not create the impression that the apparatus knows more than the operator does about what is going on inside the furnace. If this is so, the operator will find it out for himself.

Any control or apparatus must be good enough to sell itself or it is doomed to failure.

Raw Materials and Mixtures

Control must start right at the stock piles of pig iron and scrap. The manner in which a charge melts down and changes in composition is affected by the physical structure, size and shape of pig iron and scrap as well as by their chemical analysis.

Two heats of pig iron of identical analysis may not lose silicon and carbon to the same extent. Heavy scrap will not melt down with the same losses in chemical elements as light and thin scrap. This applies to steel scrap as well as to malleable scrap.

Since physical structure, size and shape are not controlled, their effect must be controlled by averaging out these variables. This control is exercised by following a few simple rules and principles.

Cars of pig iron are sampled by selecting one pig for every 5 tons. If pigs of different aspects are remarked in the car, a representative number of each kind are selected. Equal weights of drillings from each pig are mixed to form the sample for analysis of the car.

Cars of pig iron are unloaded and spread out to even thickness, one car on top of another to form piles as large as is practicable. When using from these "layer cake" piles, pig iron is loaded onto the charging barrows by taking from the face of the

pile. In this way any differences due to physical structure or size are averaged out.

Piles are made up of cars that do not vary more than 0.50 per cent in silicon content, and the average analysis is calculated by using the weights and analyses of the individual cars.

Before one pile of pig iron is completely consumed, the next pile is gradually worked into the mixture so that a change is not made abruptly from one pile to another.

Analysis of bought malleable scrap always will be a problem, but analyses of samples from the scrap pile over a period of time will furnish an average analysis that can be used in making up mixtures and, as the quantity of this rarely exceeds 15 per cent of the mixture, it becomes one of the lesser variables.

More important is the size and shape of this scrap, which should be loaded and charged in such a manner that each heat receives the same proportion of heavy and light scrap. The same remarks apply to the steel scrap used in the mixture.

Judicious segregation of foundry returns will give a supply of this material of known analysis and regular size distribution. The amount of annealed returns usually is so small that this may be grouped with the unannealed returns at the same analysis.

Mixture Calculation

If it were known exactly how much silicon, carbon and manganese would be burned out during the melting of a heat, the problem of mixture calculation would be a simple one. However, fact is not of the future, so these losses must be estimated.

Usually, manganese will take care of itself. Assuming that the loss of silicon and carbon will be the same as in any one previous heat would only be guessing or estimating with insufficient data.

In this particular foundry, practice has shown that the best pro-

This paper was secured as part of the Program for the 1945 "Year-'Round Foundry Congress" and is sponsored by the Malleable Division of A.F.A.

cedure is to consider the last six heats, eliminate the highest loss found on each element and use the average of the remaining five figures as the estimated loss for the next heat. This principle is used for the drop in carbon and silicon from preliminary to tapping, as well as from calculated analysis to final heat analysis.

Tables 1 to 5 are excerpts from the records of this data, and are used in calculating the mixture for one particular heat. The mixture is calculated just as soon as the final analysis of the previous heat has been finished.

Forms

Table 2 shows the form that is used in calculating the losses for the last heat melted and in estimating the losses for the next heat. Table 1 is a sort of running inventory of silicon and carbon losses used to calculate the average loss figures used on the form in Table 2.

The difference between the calculated analysis and the preliminary analysis (0.28 per cent silicon and 0.26 per cent carbon in this case) is carried over into columns 1 and 5 on the loss sheet. Any additions after the preliminary then are added in (0.05 per cent silicon in this case), and the difference between this and the final heat analysis calculated (0.00 per cent silicon and 0.24 per cent carbon in this case), and these figures carried over into columns 3 and 7 on the loss sheet.

Averages

Then, considering the last 6 days only, the maximum figures are eliminated (those in parentheses) and the averages made of the other five in each column. These averages then are carried back onto the loss calculation form and totaled. This total is added to the desired final analysis to give the required calculated analysis for the next heat.

Table 3 shows the mixture calculation sheet, which is almost self-explanatory. Now if the loss on this heat is the same as the average over the last 6 days, this heat will require no additions and will show exactly the desired analysis at the finish. It does not always happen exactly this way but, since our estimate is halfway between the extremes, if an addition is necessary it will be only a small one.

Tables 4 and 5 show the front and back of the form sent to the foundry weigh scales in duplicate. As sent from the laboratory, only the columns "Material" and "Per cent" are filled in along with the calculated analysis. All of the other figures on both sides are filled in by the foundry and one copy returned to the laboratory.

The foregoing is a brief outline of the method followed in calculating the mixture. The only training necessary is in ordinary arithmetic.

It is based on nothing more than the law of averages; it has a definite formula and has nothing whatsoever to do with metallurgy. Any bright grammar school graduate can do it just as well as an experienced metallurgist.

Melting Control

The foregoing method of mixture calculation is based on the premise that all of the details of charging and melting practice will be such that the loss in silicon and carbon on any one day will be within the

Table 3
MIXTURE CALCULATION
Date: Nov. 13, 1943. Heat No. 1, Furnace No. 1
Mixture

Charging Material.	Per Cent	Si	Mn	C	Si	Mn	C
Pig Iron { Car No. A.....19	1.40	0.80	4.05	0.266	0.152	0.770	
Car No. E.....6	2.15	0.75	3.90	0.129	0.045	0.234	
Car No. D.....21	1.35	0.85	4.10	0.284	0.179	0.861	
Special Sprue.....10	1.70	0.45	2.40	0.170	0.045	0.240	
Domestic Scrap.....30	1.00	0.38	2.50	0.300	0.114	0.750	
Bought Mall. Scrap.....7	0.90	0.30	2.00	0.063	0.021	0.140	
Steel Scrap.....7	0.20	0.40	0.20	0.014	0.028	0.014	
Calculated Analysis.....				1.226	0.584	3.009	

Table 4
MIXTURE
MALLEABLE FOUNDRY
Date: Nov. 13, 1943. Heat No. 1, Furnace No. 1

Material	Per cent	Weight, Lb.
Pig Iron { Car No. A.....19		6155
Car No. E.....6		1980
Car No. D.....21		7045
Special Sprue.....10		3300
Domestic Scrap.....30		9900
Bought Mall. Scrap....7		2370
Steel Scrap.....7		2310
Cal. Analysis.....Si—1.23.....C—3.01.....		
Weight of Charge.....33,000.....Started Firing.....4:00 A.M.....		
Started Slagging.....8:20 A.M.....Preliminary Test.....9:25 A.M.....		
Loads of Slag.....9.....Additions Made.....10:10 A.M.....		
Started Tapping.....10:35 A.M.....Finished Tapping.....11:15 A.M.....		

Signature

Table 5
FIRING SCHEDULE

Time	Ratio Coal to Air
4:00 A.M.	10:6
4:20	11:8
4:40	12:10
5:00	14:12
5:20	15:13

Additions

.....99.....lb. 50% Ferrosilicon
.....lb. Petroleum Coke
.....lb. Manganese Pig
.....lb. Steel Scrap

(Tables 1 to 5 and Figs. 1-5 are reprinted from a paper "Malleable Mixture Calculation and Melting Control" presented by the author at the 48th Annual Meeting of A.F.A., Buffalo, N. Y., April 26, 1944, and published in A.F.A. Transactions, vol. 52, pp. 441-458, 1944.)

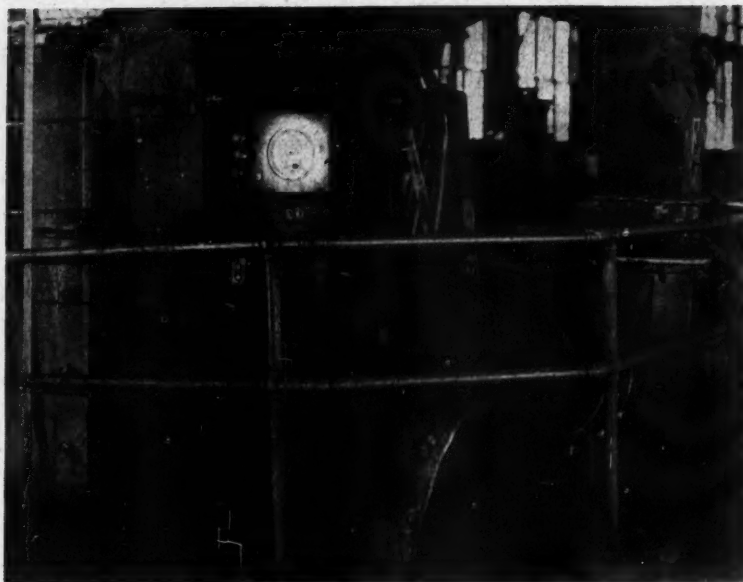


Fig. 1—Burner end of melting furnace and control board for coal- and air-feeding.

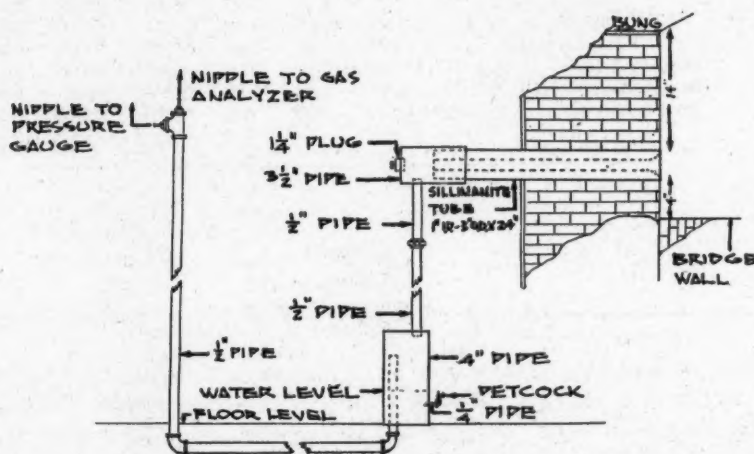


Fig. 2—Exit gas line from furnace to instruments.

range of practice prevailing over the previous 6 days, the highest loss figures excepted.

These details of practice include the charging of the furnace or the location of pig iron, foundry returns, bought scrap and steel scrap. Bought scrap and steel scrap must be in the same proportion of heavy to light from one day to another. The heat must be worked in the same manner every day as regards poling or barring up.

Fuel-Air Ratio

One of the main factors of melting control is the fuel-air ratio or CO-CO₂ balance over the charge while melting down and while superheating. The same blower gate setting and coal feed screw setting

will not always give the same CO-CO₂ balance. And even the most experienced melters cannot always visually estimate this balance from flame aspects.

Figure 1 shows the burner end of the furnace. Powdered coal is blown to the furnace from a central pulverizing station. The supply of coal is regulated by a remote control and an indicator of the speed of the feed screw at the pulverizer. A constant quantity of primary air is furnished by a fan type blower at the pulverizer and blows the coal to the melting furnace, where it enters at the center of the shutter type gate used to control the secondary air.

Analysis of exit gases will furnish indications much more accurate than visual estimation as to the

CO-CO₂ balance existing in the furnace. Sampling must be done far enough away from the burners so as to guarantee that reaction is complete. The furnace also must be operated under slight pressure so that infiltration of air through doors or other openings will not falsify gas analysis indications.

Incidentally, slight furnace pressure has been found to give the best melting conditions. Therefore, it is evident that furnace pressure must be controlled to ensure a gas sample representative of firing conditions at the burner, and that some gas analyzer must be used which will eliminate the personal element as completely as possible.

Gas Sampling

For sampling, the simplest and most foolproof combination found to date is shown in Fig. 2—a thick ceramic sampling tube built into the wall of the furnace, a piece of large diameter pipe at the outlet end, a trap with a water seal and ordinary gas pipe to the two instruments.

This set-up, installed with the two instruments, is shown in Fig. 3. The outlet from the furnace, the trap, the petcock for checking the water level, the tube going underground, nipples and rubber connections to the pressure gage and the gas analyzer.

Instruments

Figure 4 is a close-up view of the instruments. At the left, a typical boiler draft gage, each small division representing 0.02-in. draft or pressure. At the right, a gas analyzer of the thermal conductivity type, such as is used to regulate carburetors on motor cars. The original calibration of lean, normal, and rich has been changed to conform to the best air furnace practice.

Furnace Operation

At the start of firing and until pressure is built up in the furnace, the analyzer is inoperative. During this period some predetermined schedule of fuel and air feed must be used. As soon as enough pressure is built up, the gas analyzer starts to operate. From this time on the coal feed is regulated according to the indications of the analyzer. The air setting is left to the judgment of the melter, who may vary the intensity of firing by this means.

A preliminary sample is taken at

the usual point in the melting of the heat and sent to the laboratory for analysis. This is analyzed in about 20 min. and the foundry notified on three points:

1. The analysis results.
2. The corrective additions if necessary.
3. The firing method until tapping out.

Addition Computator

The last two indications are read off directly from an "addition computator" (Fig. 5).

On this computator there are two movable slides. One represents the silicon analysis of the preliminary sample, and the other the carbon analysis. The smaller figures on the outside represent the average loss after preliminary sample over the previous 6 days, and which figures are set opposite the shaded rectangles.

The slides in the positions shown indicate a 10-point drop in silicon and a 20-point drop in carbon. With the preliminary analysis at hand, one particular square on the central chart is designated. The position of this square and the figures or lack of figures in it, indicate the quantity of additions and the firing method.

Annealing Control

The annealing ovens used in this foundry are of the old periodic type, powdered coal fired. Only two pyrometer couples are installed, one at the bottom rear or burner end, and one at the opposite end about halfway up from the bottom. The ovens are fired on the indications of these couples, but since they indicate only furnace temperatures (not inside pot temperatures) and do not show the conditions in the extreme corners, more definite means of control are necessary.

Extra test bars are cast with each heat, and from these are built up a stock all within narrow and normal analyses. From this stock of test bars, 10 are annealed in each oven, these being packed at all of the extreme points. The positions are top and bottom pots in each of the four corners, and top and bottom in the center.

These bars are each given a bend test, a Brinell hardness test, and then examined under the microscope for



Fig. 3—Gas sampling tube and recording instruments.



Fig. 4—Close-up of draft-pressure gage and gas analyzer.

		LOSS SETTING →																		
MOVEABLE SLIDES	← LOSS SETTING	0.70	0.75	0.80	0.85	0.90	0.95	1.00	1.05	1.10	1.15	1.20	1.25	1.30	1.35	Average Silicon Loss after Preliminary Preliminary Sample-Silicon				
		16	14	12	10	8	6	4	2	—	—	—	—	—	—	—	50% Ferro-Silicon Petroleum Coke			
		16 <td>14<td>12<td>10<td>8<td>6<td>4<td>2<td>—<td>—<td>—<td>—<td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td></td></td></td></td></td></td></td></td></td></td></td>	14 <td>12<td>10<td>8<td>6<td>4<td>2<td>—<td>—<td>—<td>—<td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td></td></td></td></td></td></td></td></td></td></td>	12 <td>10<td>8<td>6<td>4<td>2<td>—<td>—<td>—<td>—<td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td></td></td></td></td></td></td></td></td></td>	10 <td>8<td>6<td>4<td>2<td>—<td>—<td>—<td>—<td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td></td></td></td></td></td></td></td></td>	8 <td>6<td>4<td>2<td>—<td>—<td>—<td>—<td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td></td></td></td></td></td></td></td>	6 <td>4<td>2<td>—<td>—<td>—<td>—<td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td></td></td></td></td></td></td>	4 <td>2<td>—<td>—<td>—<td>—<td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td></td></td></td></td></td>	2 <td>—<td>—<td>—<td>—<td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td></td></td></td></td>	— <td>—<td>—<td>—<td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td></td></td></td>	— <td>—<td>—<td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td></td></td>	— <td>—<td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td></td>	— <td>—<td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td></td>	— <td>—<td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td></td>	— <td>—<th colspan="4">50% Ferro-Silicon Petroleum Coke</th></td>	— <th colspan="4">50% Ferro-Silicon Petroleum Coke</th>	50% Ferro-Silicon Petroleum Coke			
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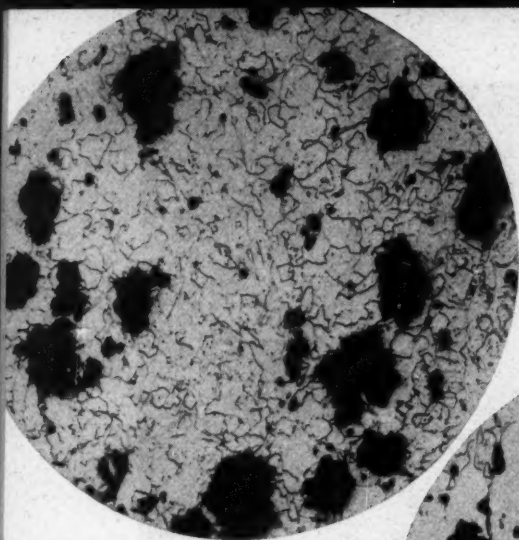
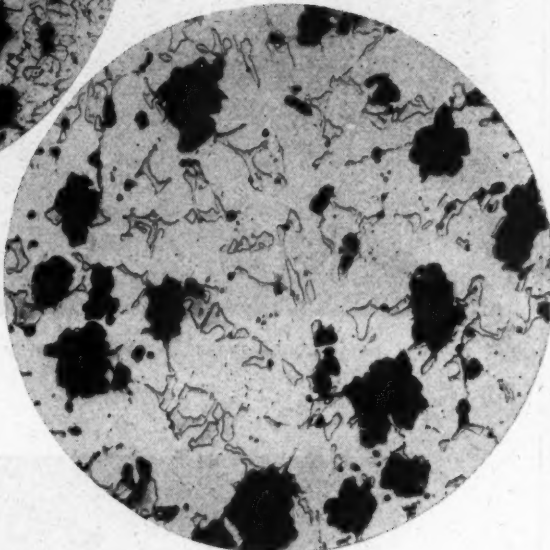


Plate II—Photomicrographs of malleable cast iron specimens showing massive cementite. Left—Nital etched. Below—Sodium picrate etched.



pearlite or cementite. From these indications firing is adjusted on the next heat. By this method faulty firing practice is corrected before the effect is serious enough to affect the castings.

Very small amounts of pearlite or cementite, although indicating faulty annealing, are not serious enough to affect physical properties or machining to a noticeable extent.

Plates I to IV show some of the structures that may be found in faulty annealing practice. These faults are shown in the order of the annealing cycle.

Plate I shows what will be recognized as normally annealed malleable, showing only ferrite and temper carbon, although it will be seen further on how, exceptionally, faulty malleable may show this same microstructure.

Cementite

Plate II shows a lack in the first stage of anneal, and indicates either too low a temperature in what is known as the soaking period, or too short a time at the temperatures attained. This is always shown by the presence of massive carbides or cementite.

The photomicrographs in Plate II show specimens etched by two

methods. The photomicrograph on the left is etched with the most common reagent, nital, or 10 per cent nitric acid in alcohol, which does not differentiate between massive cementite and ferrite. Only the peculiar shape of grain boundaries will disclose the presence of carbides to the experienced metallographer. Massive cementite grains have peculiar curved boundaries, while ferrite boundaries usually are straight lines.

The sodium picrate etch, however, will tint the massive carbides gray and leave the ferrite white, as shown on the right-hand photomicrograph taken on the same spot as the left-hand one. This massive cementite cannot be removed in the second stage of anneal.

Pearlite

Plate III shows three examples of a lack in the second stage of anneal. This fault usually is expressed as cooling too rapidly through the second stage temperatures from 1400° F. to 1300° F., approximately. This fault is evidenced by the presence of pearlite.

These three photomicrographs show three different degrees of this fault. The first is just enough to

give warning, but probably will not be even noticeable in physical properties or fracture. The second is appreciable and, although noticeable, probably would not be serious. The third, the well known bulls-eye structure, would cause a white or pepper-and-salt fracture and a serious change in physical properties, evidenced by increased hardness and tensile strength with low bend and elongation.

Plate IV shows a combination of lack in both first and second stage anneal, as evidenced by the presence of both massive carbides and pearlite, etched with nital and with sodium picrate to show how the latter distinguishes the carbide from the ferrite by darkening cementite and leaving the ferrite white.

Someone was in a big hurry to get this one annealed. They wanted it bad, and that is the way they got it—bad!

Ferrite and Temper Carbon

Returning to the fully annealed photomicrograph (Plate I) showing only ferrite and temper carbon. Once in a while (we have seen two cases in the last four years) a casting is submitted that is of normal hardness but will break short under impact, and with a completely white fracture.

When examined under the microscope, this casting shows complete anneal, only ferrite and temper carbon such as this sample (Plate I). This defect is caused by cooling too slowly after the last stage anneal, or in what is known as the subcritical range (below 1300° F.). This causes intergranular fragility, causing the metal to break through the

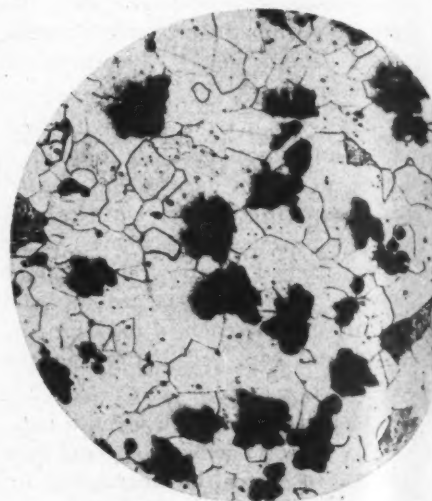
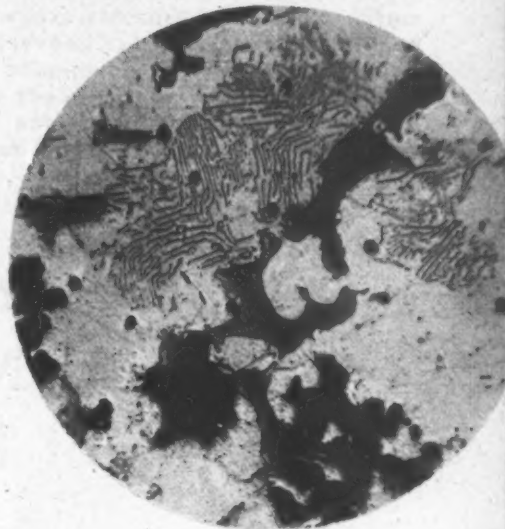
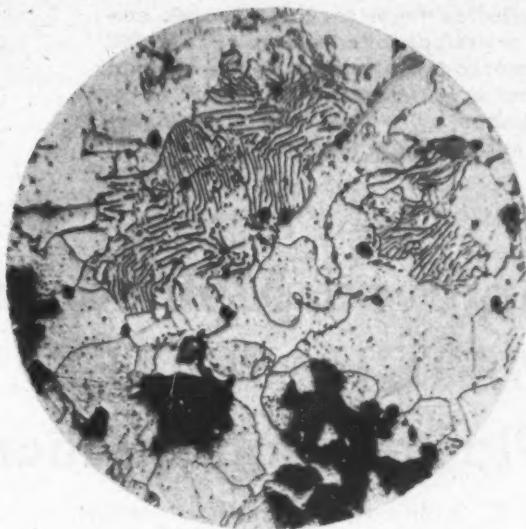


Plate IV—Massive carbides and pearlite are quite apparent in these photomicrographs of malleable cast iron specimens. Left—Nital etched. Right—Sodium picrate etched.



grains instead of along the boundaries as is normal.

The normal break along the boundaries meets numerous temper carbon nodules, which gives the normal black or mouse-gray fracture. The break through the grains meets only by chance a temper carbon nodule and causes the white fracture. This defect usually is caused by allowing a very large annealing oven to cool down from the last stage without removing doors or providing some means of final rapid cooling.

Reheating to just under the critical range (about 1200° F.) and

quenching in water will restore metal of this kind to normal properties.

Usually, if continuous microscopical control is exercised and no drastic changes in annealing practice are made from one annealing heat to another, the defects discussed will appear only in negligible quantities and can be remedied long before they become serious.

Summary

To sum up briefly, adequate malleable control may be attained by judicious sampling for analyses, proper mixing and blending of pig iron and scrap to average out vari-

ables, and by mixture control, melting control and annealing control.

One of the most difficult and probably impossible feats in manufacturing, as well as elsewhere, is to complete a series of operations twice in exactly the same manner. But how often do we hear in the plant—"But everything was exactly the same as it was yesterday." Do not we realize that if everything were exactly the same results would be likewise?

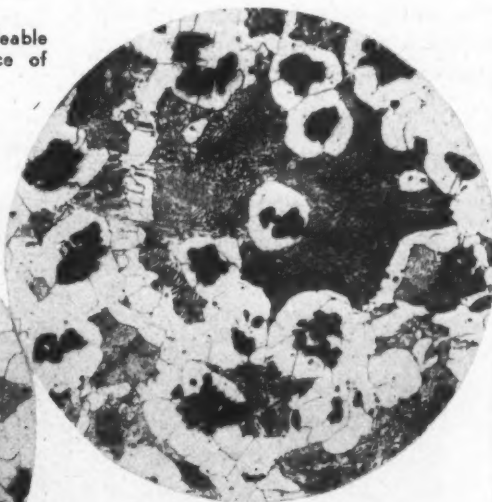
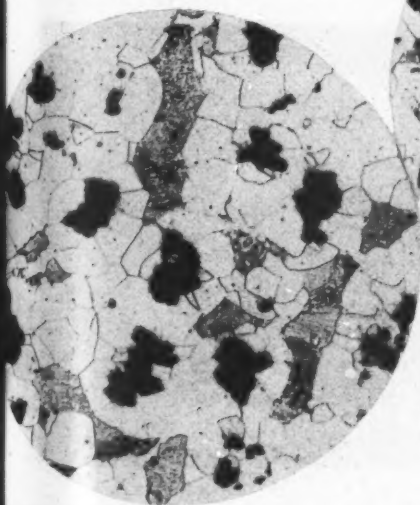
Control is simply the application of rules, habits, processes and apparatus to ensure, as closely as possible, duplication of results. Even with control, exact duplication is seldom and only accidentally accomplished, wherefore allowable variations in analyses and physical properties as well as in other specifications.

By controlling just a few of the greater variables, a marked difference will be noted in the regularity of results.

Instrument Society Formed at Pittsburgh Meeting

A NEW national society known as "The Instrument Society of America" was organized in Pittsburgh, April 28. The purpose of the Society will be to advance the arts and sciences that are connected with the theory, design, manufacture and use of instruments. Membership is open to any person, firm or institution. The Secretary is located at 1117 Wolfendale St., Pittsburgh, Pa.

Plate III—Photomicrographs of malleable cast iron specimens showing presence of pearlite in different degrees. Left—Slight pearlite structure. Below—Noticeable pearlite structure. Right—Bull's-eye structure.



• The author has conducted varied experiments with composition match plates and presents a compilation from service records embodying points of interest to every practical foundryman. Facts and figures have been set down—the methods outlined may be studied in relation to individual methods and experiments in this field. Various problems encountered—the means by which they were overcome—and the development of an entirely new technique for match-plate production are described.

Describes Improved Methods in Making MATCH PLATES of Plaster Composition

By C. C. Brisbois, Foundry Superintendent,
Robert Mitchell Co., Ltd., Montreal, Que., Canada

UPON the outbreak of war, the demand for castings was greatly increased. The development of means for producing A-1 quality castings in great quantities in the shortest possible time was of prime importance.

Not only did the quantity and quality far exceed prewar demands, but the designs of the castings were far more intricate in many cases than anything that had been produced before the war. This intricacy of pattern added to the urgency of the problem of their production, and at that time few alternatives were offered to the foundries with which to meet the situation.

All-Aluminum Plate

The all-aluminum plate with mounted patterns proved to be too slow, requiring infinite care in the mounting and cleaning processes. Mounting, cleaning, and finishing called for skilled labor, the shortage of which was even at that early stage beginning to make itself felt. Aluminum-cast plates were vetoed for the same reasons.

The author had been, through all of his years in the foundry trade, a most persistent advocate for composition-cast match plates. Up to that time the cost involved in the making of the frame, and the too frequent loss of the plate itself through breakages, had prohibited extensive use of this medium, and for these reasons it was not highly acclaimed generally. As a consequence, its possibilities were not

developed to any great extent and its adaptability to wartime demands was, broadly speaking, in the pioneering stage.

Past experiences served the author well and, when he adopted the composition-cast match plate for wartime demands, he faced the problem of its development with a great degree of confidence.

Preliminary Methods

When experiments first started in the author's foundry with plaster composition match plates, it was the general practice to make the frame in two parts—an outer frame into which an inner frame was inserted. The inside edge of each part was bevelled and, when the parts were placed together, formed a V-shaped

groove on the inside of the completed frame (Fig. 1).

This groove provided anchorage for the plaster compound when poured into the frame, and the two parts were held together with screws. The entire frame had to be machined, both sections, top and bottom. The inner frame had to be fitted to an exact bearing into the outer frame and onto the groove.

A perfect bearing was essential to prevent any possible flexing between the two sections. Such a flexing, were it present, would cause the plate to crack or break after being in production for a short time, if not before.

In addition to the machining, the inner section of the frame had to be

Fig. 1—Old-style frame showing two parts.



This paper was secured as part of the Program for the 1945 "Year-Round Foundry Congress" and is sponsored by the Patternmaking Division of A.F.A.

drilled and tapped for fitting into the outer section. The greatest of care had to be exercised here, also, to obtain an even bearing.

The inner section was designed to be removed from the outer section for the purpose of removing the composition plate, which then could be replaced by another. One frame was thus kept continually in circulation, while plates were stored against further requirements, after their first run.

Disadvantages Encountered

It became more and more evident through experience in the use of these frames that the normal life of the plate was shortened by this method. Time prohibited thorough development of this theory, but the fact that a plate would produce from 300 to 500 molds with little trouble so long as it remained in the frame as cast, and that cracking or breaking occurred almost immediately after the plate had once been removed from and replaced into the frame for a second run, was of sufficient significance to warrant suspicion.

It was believed at first that when the plates were replaced in the frame for a second run, an uneven bearing had resulted from the removal of the plate from the frame. In an

effort to maintain an even bearing, soft putty, wax or a plastic compound, was often used, but with little improvement of the situation.

The theory that these plates became damaged on the racks when not in use was discredited when it was assured that every care was taken to protect them. A special rack was designed and used for their storage, and a similar but smaller rack was erected in the foundry for their protection during production (Fig. 2).

Each plate was removed from the machine at the end of the day's run and placed in this foundry rack. A trustworthy man was appointed to carry these plates to and from the rack during production, and to the storage rack at the completion of the job. Each plate was carefully examined before each day's production run but, with all these precautionary methods, the trouble recurred with provoking regularity.

To definitely establish causes for cracks or breaks would necessitate a prolonged and careful study of all contributing factors. The author was not concerned with proving his theories at that time, but mainly with developing and improving technique.

New Type Frame Developed

The author's first concern was to cut down or overcome the loss of plates. In support of his theories, the old type two-piece frame was abandoned. In its place he developed an entirely revised one-piece frame (patent applied for), designed primarily to protect the plate against cracking, breaking or other damage.



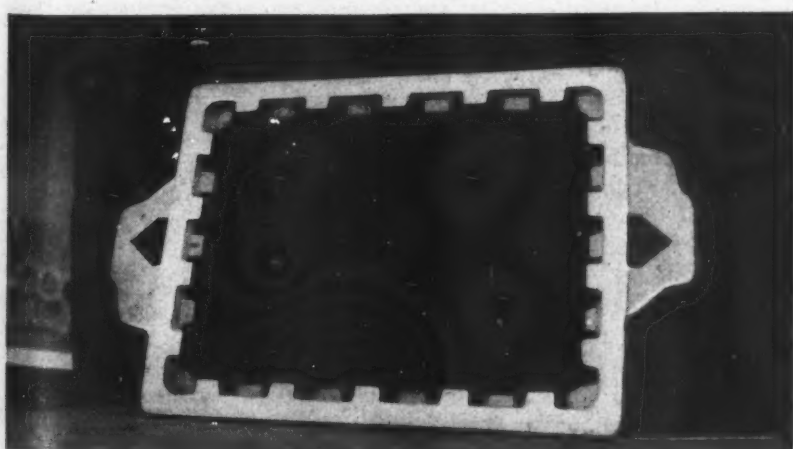
Fig. 2—Specially designed storage rack.

At first glance it may seem that to confine a frame to one particular plate throughout the lifetime of a job would be a costly process, but the author worked on a theory that if a cheaper type of frame could be designed to cut down plate loss, having the advantages of the old type but none of its disadvantages, it would justify itself financially. How sound this theory proved to be will be shown later.

Originally, the two-piece frame had been designed for the purpose of facilitating the mounting of different patterns and to permit the removal of plates and the insertion of others, to cut down the necessity of making too many frames. The labor and machining involved made the use of these frames costly, and the idea was to make one frame do as much work as it could be adapted to.

It is obvious, however, that the saving was in the frame itself; the cost of the patterns, molding of the plate, and storage, remained the same, while the financial loss through damaged plates far exceeded the economical value of the frame. It was logical, therefore, that the first step should be toward developing a low-cost frame having as its pri-

Fig. 3—New type frame made in one piece.



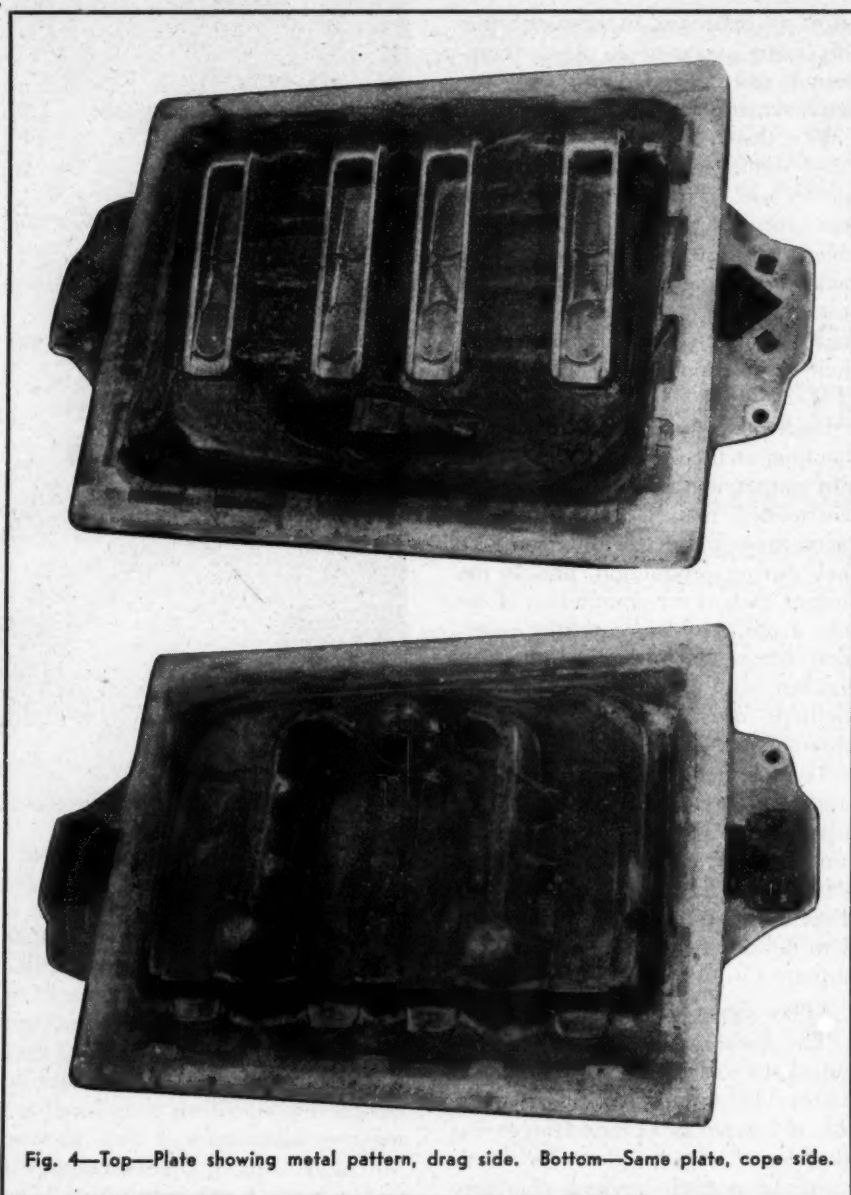


Fig. 4—Top—Plate showing metal pattern, drag side. Bottom—Same plate, cope side.

mary function the protection of the plate against damage.

Frame Casting

Instead of the two-piece, double-molding operation of the old type, the new frame is cast in a single molding operation which draws out of the mold without cores, complete with supporting projections and lift handles (Fig. 3).

Solid projections or teeth about an inch wide are cast flush with the frame at intervals of about 2 in., alternating from bottom to top of the frame. No special care is required to cast these teeth smooth, as a certain amount of roughness will lend further support to the plaster compound in the frame. Steel strips or wires are supported by these teeth for further reinforcement.

The handles are cast like large, V-shaped holes with sufficient clearance to allow insertion of standard V-shaped pin guides. The guides, made of brass and cast to size, require file-finishing only to fit.

Frame Thickness

The thickness of the frame may vary. That is to say, one frame may be 1 in. thick, while another may be $\frac{3}{4}$ in. thick, but whatever the thickness of the individual frame, it must be maintained throughout the entire frame.

The 1-in. frame is preferable since it will support the minimum amount of compound with the maximum of strength. Approximately $\frac{1}{16}$ -in. machining is necessary on the back and front of the frame. As these surfaces are perfectly flat, the ma-

chining process is very simple and inexpensive.

Frame Molding

The molding of the new type frame is a very simple operation throughout, involving a minimum of unskilled finishing labor. Eliminating as it does the necessity for skilled labor, this feature is a recognizable advantage over the old type frame.

Further, this economical feature of the new type frame is not confined to the molding operation alone, nor does the fact that it is confined to one job for a longer period of time detract from its productive value.

The life of the new type frame is as long, if not longer, than that of the old type, and will go on through production of other plates for many years. Both the old and new type of frame are cast in aluminum. Wear and tear being equal, there is nothing to indicate that the normal life of each type is not equal.

As with the old two-piece type, the new one-piece frame becomes available for another plate immediately the production schedule of one plate is completed. The plaster compound is broken up, all patterns carefully removed and cleaned, stored or returned to the customer, as the case may be, and the frame is ready for another job.

The saving effected through the use of the new type may not at first be apparent, but, failing a comparative cost study through the actual use of both types of frames, which the urgency of the need prohibited at that time, the economical potentialities of the new type cannot fail to be recognized. Service records indicate that, through the preservation of plates for the lifetime of the job, production costs have been cut as much as 50 per cent or more.

Comparative Mold Production

To emphasize this point, plates which have produced 10,000 and more molds, using the new type one-piece frame, are in the storage racks of the author's foundry; still in excellent productive condition. The highest quantity on the records of molds produced off one plate in one run, using the old type two-piece frame, is 1000.

These figures are given to emphasize the value of plate protection. This does not prove that the plate which produced 1000 molds while in the old type frame, would not

have gone on through production of 2000 or even 5000 molds, if left in the frame as cast. The point indicated here is that 1000 molds is the highest quantity of molds ever produced in the author's experience without removing the plate from its original frame.

Once the plate had been removed from the frame and replaced for a second run, the plate broke or cracked and was useless for further runs. How many plates would have had to be remade to produce as many as 10,000 molds by this method, is a matter of conjecture.

The point is that a plate in the

new type frame will produce 10,000 and more molds with very little, if any, further expense than the initial cost of making the plate up, and still be in good working condition. Over and above the reduced molding cost of the new frame, this feature further reduces actual production costs many times over.

Wires Still Used

While wires are still used to reinforce the plaster compound, as with the two-piece frame, this practice is not so favored with the new frame. The use of wire, except where absolutely necessary, is not highly recommended as a general practice.

When wire is used, care must be taken to determine the exact size suitable for the job. Too thin a wire has a tendency to "spring" and too thick a wire requires more compound to cover and, consequently, a plate too thick and too clumsy to handle. Costs of plates being based on weights, the cost is proportionately higher. In both cases, the plate is weakened instead of being strengthened.

It was noted that cracks most frequently occurred directly over the wire when thick wire was used. This would indicate that there was not sufficient compound in the frame to permit of a thick enough layer over the wire.

Even with the 1-in. frame, which will support the maximum amount of compound, this tendency was apparent. To make a thicker frame to accommodate a sufficient quantity to cover a thick wire, would result in a plate too awkward, too costly, and too heavy to handle with proficiency.

This tendency was not apparent when using thin wires, but the com-



Fig. 5—Above—Elbow pattern showing loose flanges cast in aluminum.

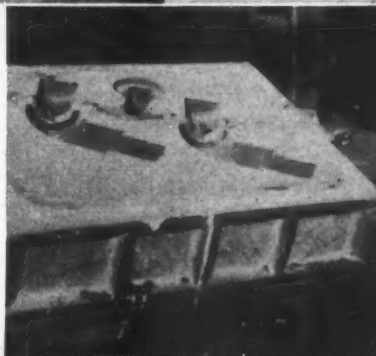


Fig. 6—Right—Mold with flanges in place, anchored firmly to compound.

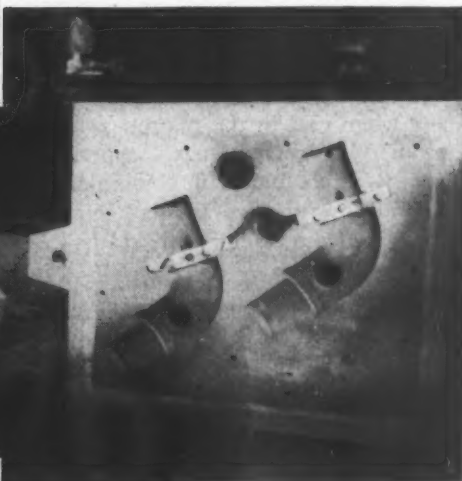
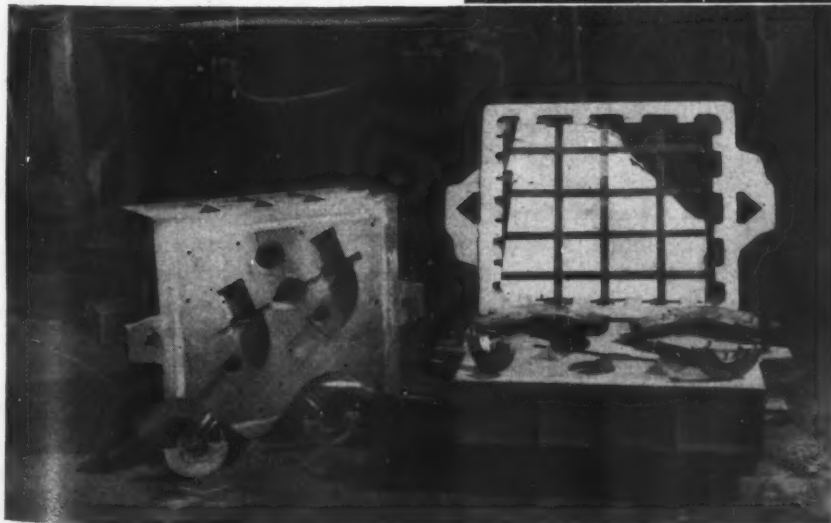


Fig. 7—Below—Mold all ready for closing.



pound would more frequently break away from the sides of the frame. Had time permitted a more detailed and lengthy investigation of the behavior of wires, more definite and interesting data might have been discovered as to cause and effect.

Steel Strips

As it was, theory again carried the day and, in an effort to overcome these disadvantages, wires were replaced almost exclusively by metal strips. Previous experiments had proved most successful and, with the abandonment of wires, time was

now devoted to the development of proper technique for the use of strips.

Mild steel was found to be the most suitable. Standard type of steel strips used was No. 10 U.S.S. Standard (approx. $\frac{1}{8}$ in. x $\frac{1}{2}$ in.) length cut to size. Whenever possible, requirements are confined to the No. 10 steel.

All strips are sandblasted before use, to insure a very clean surface so that the compound will stick evenly and thoroughly. Strips are placed at strategic points in the frame, criss-cross fashion, and anchored firmly into place on the teeth with wire or nails. In complicated patterns, steel strips may be bent to follow the contour of the pattern.

Technique of Combining Metal and Plaster

The author does not contend that all patterns can be produced from match plates. In certain types of pattern it is not possible to utilize this medium. Again, certain types of pattern cannot be cast solid in plaster compound with practicability.

For instance, in the case of a pattern having bosses, ribs, or thin sections projecting on one side only, it was found that such parts were liable to be broken, nicked, or damaged, when cast in the plaster compound. With such patterns, experiments were conducted in combining aluminum with the plaster compound, and the results were gratifying (Fig. 4).

The technique was simple. First, solid patterns were cast in aluminum from master patterns. The side of the patterns having ribs, thin parts, or bosses, was placed in the drag, and the opposite side drilled and tapped and screws set in to act as anchors to the cope.

Anchoring Patterns

Patterns were left in the mold when pouring the plate. The finished plate showed the cope in solid compound and the drag the metal patterns, firmly anchored into the compound on the cope, projecting clear above the plate. The metal patterns were proof against breakage or other damage (Fig. 4).

The size of the patterns determines the size of the screws to be used. The average size is No. 10-32th. x $\frac{3}{4}$ in. The largest used by the author are 24th. x $\frac{1}{4}$ in. It was

Fig. 8—Right—Cleaning the plate.

found that flathead steel machine screws were the most adaptable to requirements.

Elbow Pattern

To illustrate this method to better advantage, the author presents for example an elbow pattern having flanges on one end. These flanges extend above the main body of the pattern and there is danger of their breaking if cast solid in plaster compound.

A combination split wood and metal pattern is first made. In other words, the body of the elbow, including coreprints, is made of wood and the flanges are cast in aluminum, left loose, and recessed in the body of the wood pattern (Fig. 5).

After the pattern is drawn from the sand, the loose flanges are put back into their impressions with screws in place, by which they are anchored firmly into the compound (Fig. 6).

Gates are then cut in the sand and risers or vents indicated. The mold is finished and the frame is laid on the box joint. The number and placement of steel strips is then determined and the strips anchored into place. The mold is then ready for closing (Fig. 7).

After pouring, the plate is brushed and all sand cleaned off. The risers are cut off and the plate carefully examined for cracks or other minor defects, such as shrinkage or porosity. If any such are apparent, repairs are made immediately, while the compound is still wet. Left-over compound is used for this patching operation.

The plate is then sent into the pattern shop where it is put aside to dry. Approximately 5 hr. is sufficient drying time, and plates should be allowed to dry at room temperature for best results.

Drying and Cleaning Plates

When time is limited, or for rush jobs, plates have been dried by hooking them up over steam radiators. This will dry a plate sufficiently for working in approximately 2 hr., but except where unavoidable this practice is not recommended. After the plate is dry, finishing girls clean up and shellac the whole plate (Fig. 8).

The following comparative table,

derived from service records, demonstrates conclusively the time saved by the composition match plate over the all-aluminum plate.

Combination Metal and Plaster Composition Plate

Time required to make two combination wood patterns with loose metal flanges, hr.....	30
Cleaning and fitting patterns, hr. ..	7
Total time, hr.....	37

Metal Patterns Set on Aluminum Plate

Time required to make wood master pattern and two aluminum split patterns, hr.....	40
Cleaning and fitting patterns, hr. ..	24
Total time, hr.....	64

Core boxes, dryers, etc., required the same time in both cases and are, therefore, not shown on the table. There is a straight 42 per cent saving in hours, but time is not the only saving. A monetary saving is also effected, not only by cutting down the hours but by employing unskilled finishing labor.

Plaster vs. Aluminum Plates

With the plaster composition plate, finishing girls at a lower wage will do the required finishing with efficiency, but skilled labor at a much higher rate of pay is essential for finishing the aluminum plate. It is quite probable that, in most cases, the difference in the wage scale between these two classes of labor might well be 50 per cent.

The author does not wish to convey the idea that he believes the plaster composition plate or the combination of metal and composition plate better than the all-aluminum plate. He does wish to emphasize the fact that they are more flexible to work with, less expensive and faster, and will produce as good a casting as the aluminum plate, which

is, after all, the most important factor. Thousands of castings have been produced off these combination plates—castings with tolerances as close as 0.015 to 0.031 in. in the Class I (to be X-rayed) category.

Alterations

After the plate has been made, alterations to gates or patterns, should any be necessary, can be done with much more speed and facility on the plaster composition plate than is possible on the aluminum cast plate.

For instance, should the gates need to be changed, they are simply cut off, small cigar box nails inserted to act as an anchor for the compound, new gates shaped to the required size in clay and the compound poured. When dry, the new gates are trimmed and smoothed off with a chisel and the plate is ready for production.

Should patterns require to be built up $1/16$ in. or $1/8$ in. or less, very small nails are inserted for anchors and compound added and built up to more than the required size. After the compound is dry, it is trimmed down to the necessary size. Compound will adhere to compound with such tenacity that the addition will not be discernible. A smooth, clean and permanent job is the result.

Every patternmaker knows what a job it is to build up a pattern on an aluminum-cast plate. First, a brass or aluminum sheet of the required thickness must be screwed or riveted onto the pattern. Lead must be worked into and over the screws or rivets to insure a perfectly smooth finish. A great deal of time and care are required to trim the addition down to the right size to attain a smooth and even surface. At best, in most cases, the result is a patch-up job.

Conclusion

In conclusion, the author relates an actual incident whereby the substantial saving which can be attained through the utilization of plaster composition plates, can be carried on through production in the foundry to the customer outside the foundry.

A quotation was solicited on a certain job. It was a small job and a short run, but it was important and it was urgent, as even the smallest jobs are in wartime. At the same

time, it was not worthwhile to the customer to put too much money into the job. Solid patterns were available, and it was suggested to the customer that these be used to cast on a plaster composition plate.

The customer immediately protested the cost of plates, but when it was pointed out to him that the cost of a plate in plaster compound would be approximately a third less than that of an all-aluminum plate, while at the same time patterns would be preserved and returned intact at the completion of the job, the proposition was accepted with alacrity.

The advantage of this proposition was that the patterns could be returned intact to the customer at the completion of the job, but of equal importance was the small sum of money involved, the facility of production, and last but not least, the speedy delivery promised.

Further, should additional castings off this plate be required at some future date but with some alterations necessary to the patterns, no great financial loss would have been

incurred by the removal of the patterns from the plate, involving the breaking up of the compound only.

Had these patterns been mounted on an aluminum plate, alterations to patterns would have resulted in a much greater financial loss, or had the old type two-piece frame not been superseded by the more economical, more facile and speedier one-piece type, this gratifying and purposeful suggestion could not have been made available to the customer.

This is only one of thousands of such demands which we have been called upon to meet during wartime, but unlike the beginning, a medium by which such demands can be met and fulfilled is now at our disposal.

Acknowledgment

Permission to prepare this subject for presentation was granted to the author by his principals, the Robert Mitchell Co., Ltd., to whom he expresses his thanks and his appreciation for their cooperation during the development of his subject.

Book Review

By Herbert F. Scobie

Colorimetric Determination of Traces of Metals, by E. B. Sandell. 470 pages. Published by Interscience Publishers, Inc., New York. Price, \$7.00.

This book contains valuable information for metallurgists and chemists who are required to keep close control over scrap metals or metal products, or who are engaged in experimental or research work. In a laboratory which needs to make analyses of traces as small as 0.00001 per cent, but does not have a spectrophotograph, the book presents some pertinent data.

The author, who has had experience with most of the methods described in the book, presents procedures for analysis for traces of 45 of the elements as well as the rare earths. Several methods are described for each element and in many cases these are critically evaluated. The methods described by the author include analyses for "the determination of a minute quantity of a substance . . . in the presence of an overwhelming quantity of

other substances" for a wide variety of materials such as alloys, ores, silicate rocks, water, biological specimens, and air.

The first fifth of the book is devoted to a discussion of the theory and technique of colorimetric and spectrophotometric methods. Mention is made of amperometric, polarographic, and other methods of analysis. Chapter IV on General Colorimetric Reagents is excellent and includes organic and inorganic reagents.

The balance of the book deals with specific analytical methods. Each element is discussed under the headings of Separation, Methods of Determination, and Applications. It is significant that many of the applications are to metals and alloys of industrial importance.

Boron and tellurium (which is only slightly less metallic than arsenic and antimony), are not mentioned. In view of their increasing importance in the iron-carbon alloys, metallurgists should appreciate convenient colorimetric methods for traces of these elements.

There are over 450 references to other works.



Specimen No.
Height of sound
Metal, inches

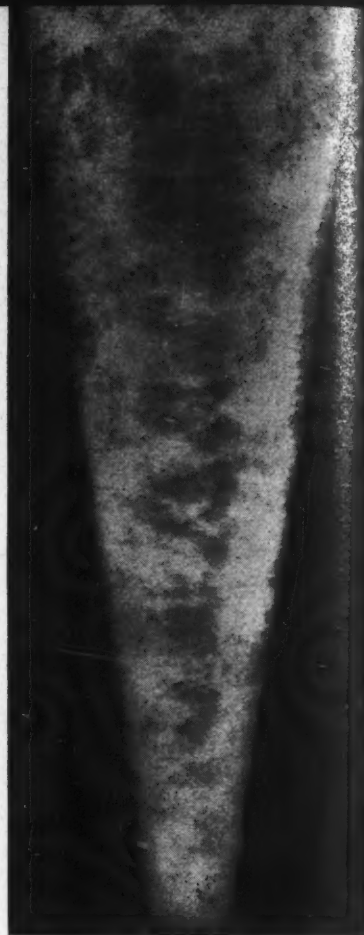
87B

$\frac{1}{8}$



98B

$\frac{1}{8}$



124A

$\frac{1}{2}$

Reduction of Microporosity in Magnesium Alloy Castings

FROM the viewpoint of soundness of magnesium alloy castings, both the user and the producer are concerned primarily with the defect known as microporosity. Among light-alloy foundrymen, this term is used more or less interchangeably with "microshrinkage." The latter term is more specific, for it implies that the defect is caused entirely by shrinkage. For reasons which will become obvious, the term "microporosity" will be used in this paper.

Microporosity is by no means a malady characteristic of magnesium-base alloys only. It is common in

By James DeHaven and James A. Davis, Research Engineers, and L. W. Eastwood, Assistant Supervisor, Battelle Memorial Institute, Columbus, Ohio

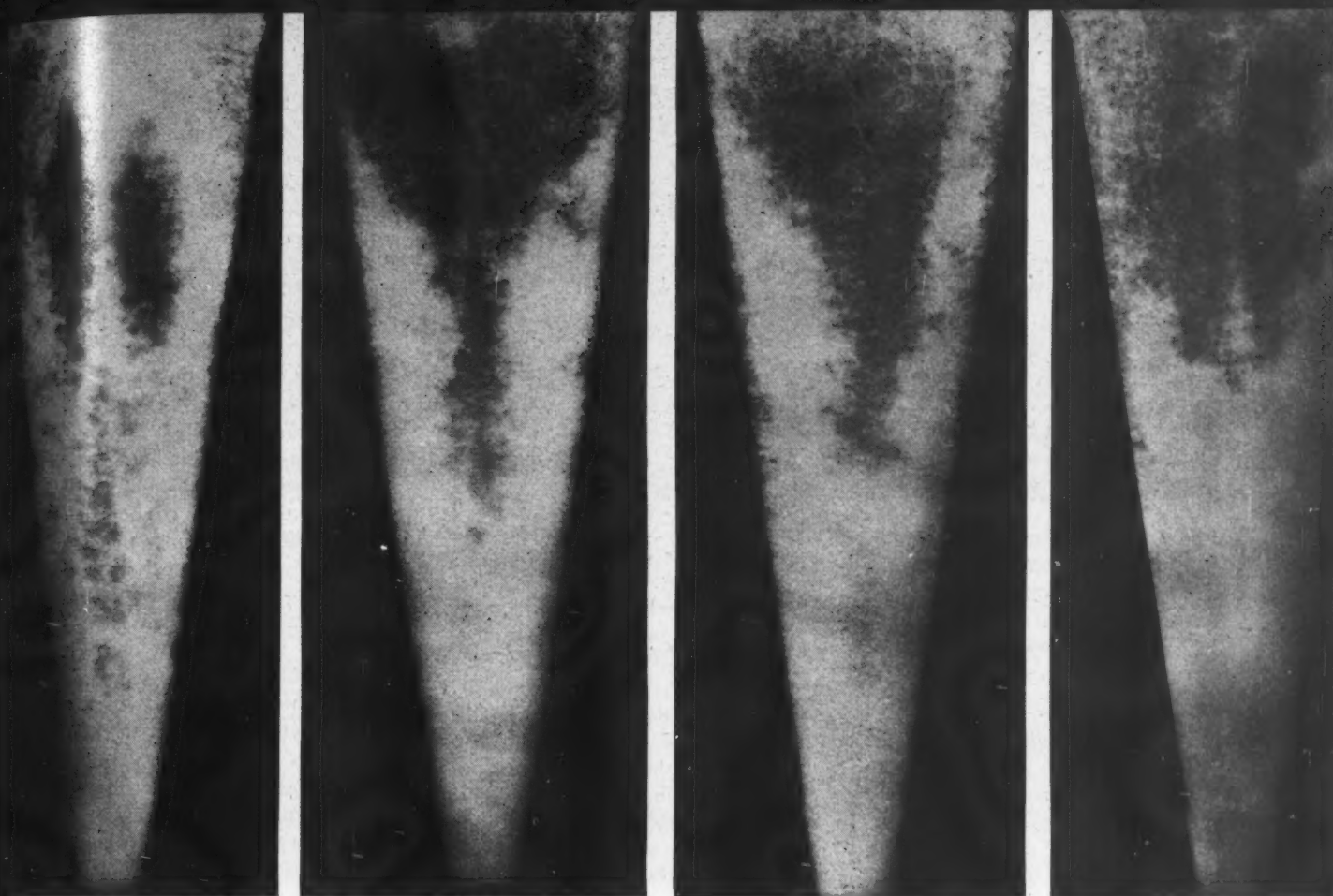
commercial solid-solution type of alloys regardless of the base material; i.e., those alloys having a considerable range of solidification and forming little or no eutectic liquid during solidification.

It is especially common in high-purity commercial solid-solution type aluminum-base alloys containing

magnesium and/or zinc, and in the high-purity binary alloy containing up to about 4.5 per cent of copper. It is also common in many copper-base casting alloys, in which it is known variously as "oxidation," "shrinkage," "gas porosity," and "incipient shrinkage."

The appearance of microporosity in magnesium alloys is illustrated by the accompanying figures, which show it by means of X-ray and by microphotographs. Specifically, microporosity, as shown by Fig. 10, consists of small voids more or less interconnected to form colonies, the

*** Laboratory and production foundry tests results indicate that the occurrence of microporosity in magnesium alloy castings may be markedly reduced by the use of melt degassing methods described in the paper.**



Specimen No. 84A
Height of sound
Metal, inches 1 $\frac{3}{8}$

90A
2 $\frac{1}{4}$

101B
2 $\frac{7}{8}$

76D
3 $\frac{1}{2}$

Fig. 5—Radiographs of sections cut from wedge casting showing various heights of sound metal, corresponding to variations in gas content of melts.

individual voids being visible only under a microscope, but the colonies may be visible with a naked eye on carefully machined, ground, or polished sections. The individual voids usually lie between the grains, but may occur between the axes of the dendrites forming the grains.

After the castings have been heat treated, the fractures through sections containing microporosity are discolored, the shade of the discoloration depending upon the amount of the microporosity. In general, the color has a slight tinge of straw yellow when the microporosity is not severe, the color increasing in intensity through brown, gray, and black with increasing amounts of the unsoundness. This unsoundness has an adverse influence on the mechanical properties, the effect on the properties of test bars cut from castings being as follows:¹

Color of Fracture	Relative Value	
	Tensile Strength	Elongation in 2 in., per cent
Clean, sound	100	100
Pale yellow	78	70
Brown	68	60
Gray, black, purple	50	30

This adverse effect of microporosity on the tensile properties is very serious indeed, and while no data are at hand, it is quite likely that the adverse effect on the fatigue life would be even more severe. This would be expected because the microporosity forms angular discontinuities, a form of defect which acts as a stress raiser in the casting.

In view of the occurrence of microporosity in commercial castings which are considered to be of fairly good quality, it is evident that the problem is a serious one and merits considerable attention on the part of both the user and the producer of magnesium castings.

Practical Methods of Measuring Degree of Microporosity

There is no reliable method of precisely measuring the degree of microporosity in a casting, but there are methods of roughly estimating the severity of the defect. These

methods are (1) fracturing the casting after heat treatment, (2) preparing sections of the casting and observing the unsoundness under the microscope or revealing the unsound areas by using oil and chalk, and (3) X-raying the casting.

The first two methods are destructive and, therefore, have their limitations. They are both thoroughly reliable, but they show the degree of unsoundness only on the section fractured or polished. The X-ray method does not have the limitations of the first two methods, but, unfortunately, radiography is not too reliable unless its limitations are realized and the results are intelligently interpreted.

The X-ray shows the microporosity reliably and very well when dealing with reasonably thin sections which lend themselves to good exposures. Unfortunately, most commercial castings are too complicated for good X-ray "shots" and, under

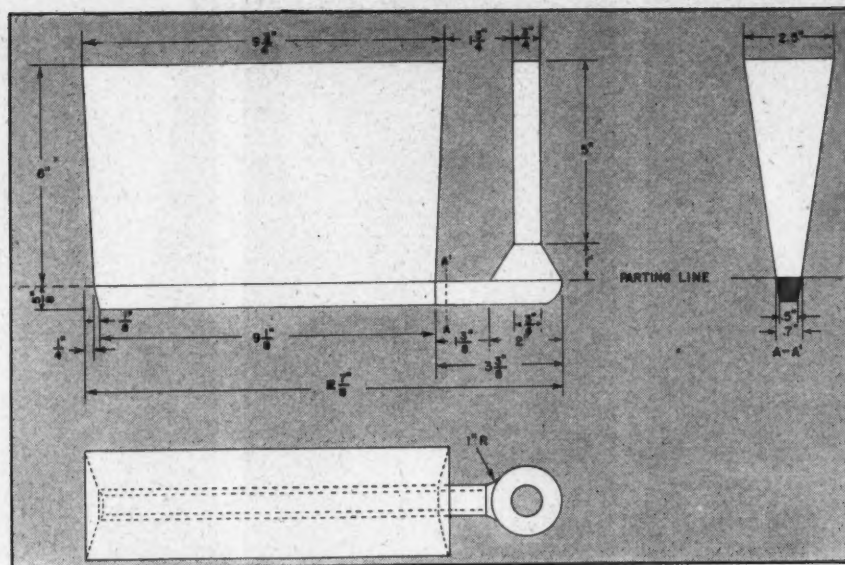


Fig. 1—Views of the wedge casting used in the investigation.

these circumstances, the X-ray may provide a clean bill of health for the sections which are difficult to X-ray, but show unsoundness where the X-ray exposure is more favorable. Even with good exposures, only severe cases of microporosity may be discovered in heavy sections.

Because of these limitations and the expense involved, many foundries rely mostly on the fracture test to determine the quality of the castings in respect to the occurrence of microporosity. This may be done by (1) fracturing a certain percentage of production, say every twentieth casting, regardless of whether or not the casting is scrap, or (2) fracturing all or a portion of the scrap, since this can be safely assumed to be representative of the production in respect to the occurrence of microporosity.

Since the microporosity shows on the fracture as a discoloration after heat treatment only, the solution heat treatment must precede this test. Also, because aging makes the castings more brittle, the fractures will be smeared less if the aging treatment has been carried out. Most foundries use a hydraulic press or a mechanical shear for the fracture operation, both machines requiring wire shields for the protection of the operator.

Experimental Methods

Melting and Molding Procedure

All melts were made in 60- or 130-lb. steel pots in a gas-fired furnace, using regular commercial

melting methods, except as noted in the data. The molding sand consisted of a synthetic green sand prepared by mulling washed Ottawa silica sand with 4 per cent of bentonite, 5 to 6 per cent of inhibiting agent No. 190, 1.5 per cent of

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ethylene glycol, and about 2 per cent of water. This sand had an A.F.A. permeability of 95 to 110 and about 9 psi. compressive strength. Molds were made by jolting to a mold hardness of about 60.

Early in the experimental work, it was discovered that a considerable variation in the amount and

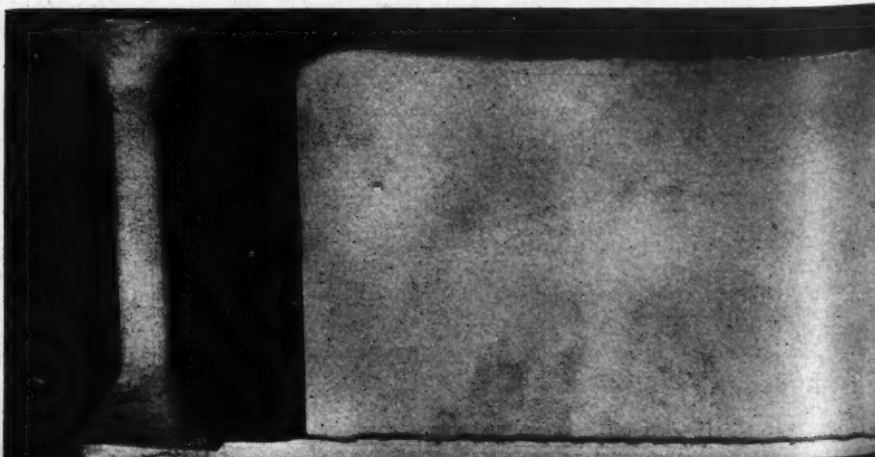
location of microporosity occurred in a wedge casting being used to provide bars for certain mechanical tests. This led to an investigation of the causes of these variations as a first step in the experimental program, and the wedge casting and the 4-bar pattern were used for this phase of the work. The wedge casting is shown by Figs. 1 and 2; the test-bar casting by Fig. 3.

The susceptibility of the melt to form microporosity in the wedge casting was determined by cutting a vertical section $\frac{1}{2}$ in. thick from the center of the wedge, smoothing the surfaces and revealing the microporosity by using the chalk and oil method, or by X-raying the section. Since these sections are ideal for X-raying, this method, checked by the oil-chalk method, was employed to show the amount and distribution of the microporosity.

Figure 4 shows the distribution of microporosity in the wedge casting poured from a good quality melt, i.e., one which produced about $3\frac{1}{2}$ in. of sound metal in the bottom of the wedge. The gate was at the end marked on the X-ray film, and it is evident that less microporosity occurred in this portion, but its distribution is otherwise uniform throughout the length of the wedge.

The vertical $\frac{1}{2}$ -in. section cut from the center of the wedge, therefore, may be regarded as being representative of the casting. Melts varied considerably in respect to height of sound metal in the bottom of the wedge. This variation was found to be from 0 to about $3\frac{1}{2}$ in., depending upon the melting technique and melt treatment. These variations in melt quality as represented by their susceptibility to form microporosity are shown by the photographs of

Fig. 2—Photograph of the wedge casting used to measure the susceptibility of the melt to the formation of microporosity.



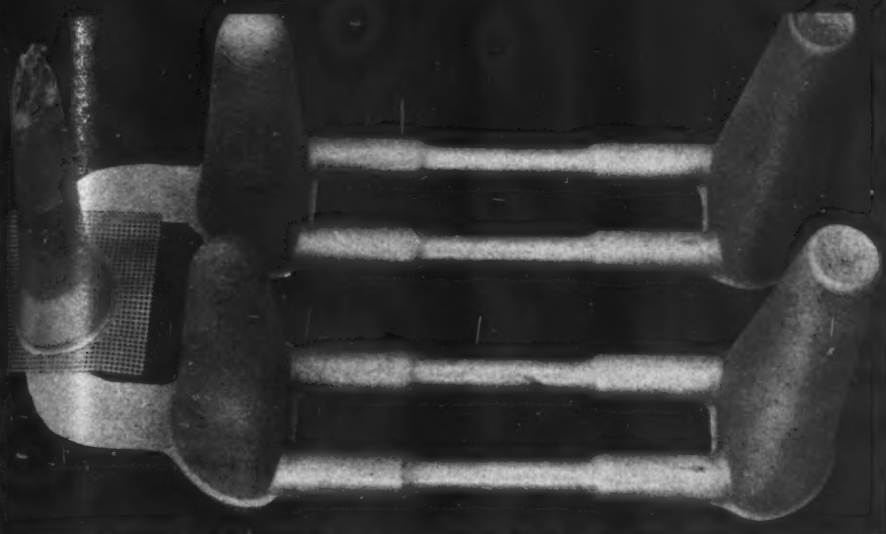


Fig. 3—Photograph of the four-bar pattern test-bar casting.

X-ray films presented in Fig. 5.

The section at the left in Fig. 5 was poured from a gassy melt very subject to the formation of porosity, in this instance macroscopic in size. The melt quality improves successively from left to right, the last one having $3\frac{1}{2}$ in. of sound metal at the bottom of the wedge. This amount of sound metal was about the best that could be obtained in the wedge casting except by the employment of special means, such as by using an air vibrator on the mold or exothermic compounds on the risers.

It was found that the test bar properties did not reflect the melt quality in the range encountered in this work unless the melt was deliberately gassed. Since all of the test bar properties were very good, unless they were poured from purposely gassed metal, no test bar data are listed in this paper.

Gas in Magnesium Melts

The possibility was investigated that dissolved gas in the melt might account for the variation in the susceptibility of the metal to microporosity in the wedge casting. In view of the strongly reducing nature of molten magnesium, it is not likely that such common gases as CO, CO₂ and SO₂ would be the cause of much trouble, for these gases would be decomposed by reduction.

Nitrogen forms a stable nitride, and it also is not likely to be a cause of difficulty from gas evolution during solidification. However, magnesium melts, like those of aluminum, might dissolve hydrogen. Winterhager² tentatively found that the solubility of hydrogen in magnesium was as shown in Table 1.

The solubility values given in

Table 1 are remarkably high and would warrant checking. Magnesium alloy melts generally are considered to be free of gas absorption

Table 1
SOLUBILITY OF HYDROGEN IN
MAGNESIUM

Temperature, °C.	H ₂ per 100 grams Metal, cc.
650 solid	18
650 liquid	26
700 liquid	26
800 liquid	27
900 liquid	31

difficulties, probably because no macroscopic evidence of gas, such as pinholing, occurs in the castings. A very considerable amount of evidence has been accumulated that magnesium alloy melts can and do

absorb hydrogen, and this is amply demonstrated by the experimental results described in the following paragraphs and by the photograph (Fig. 11).

Experimental Work

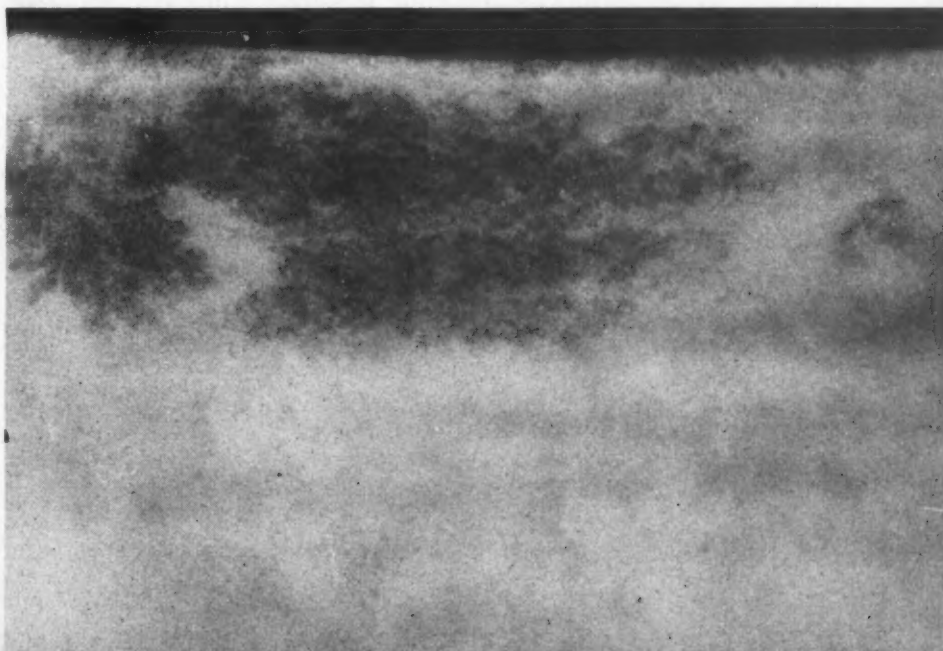
The Effect of Hydrogen Additions

A number of heats were prepared whereby careful melting methods were used to avoid gas absorption and to provide a good quality of metal. A control wedge was then poured, for purposes of comparison, to show the height of sound metal in the wedge prior to the special treatment. The remaining melt was then treated in various ways to add hydrogen to the melt, after which another wedge was poured.

Sections from the wedges were cut and X-rayed as described previously, and the relative soundness, i.e., the height of sound metal in the bottom of the wedge, was measured. Using ASTM-4 alloy, the effect of gassing the melt was found to be as indicated by the data provided in Table 2.

These data clearly show that if ordinary tank hydrogen is bubbled through the melt, the wedge poured from it will contain more microporosity than the wedge poured before the hydrogen addition. Apparently, also, it is the moisture in the hydrogen rather than the molecular hydrogen which causes the gas absorption. This is a characteristic of biatomic gases, for, if they are produced in atomic or nascent form,

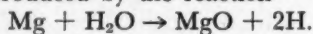
Fig. 4—Radiograph of the wedge casting showing the distribution of microporosity represented by the dark, cloudy areas on the photograph.



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they are much more active than the molecular gas.

The atomic or nascent hydrogen is produced by the reaction



The H is very active, whereas H_2 is not sufficiently dissociated at the temperature of the magnesium melt to be absorbed to any noticeable extent by the 5-min. treatment in Heat 97.

Other sources of atomic hydrogen, such as NH_3 and metallic hydrides, also gas the melt and markedly decrease the height of sound metal in the wedge. This is illustrated by the data in Table 3.

These data clearly show that atomic hydrogen supplied as moisture, ammonia, or as metallic hydrides will, if added to the melt,

greatly increase the amount of microporosity as measured by the height of sound metal in the wedge casting.

If it now be granted that an increase in the amount of hydrogen, apparently in atomic form in the melt, causes an increase in the amount of microporosity, the question then becomes a dual one: (1) how may the hydrogen be kept out of the melt, and (2) if it enters, how can the hydrogen be eliminated from the melt?

In respect to the first part of the question, the melting practice is the principal factor determining the amount of gas in the melt, which in turn reflects the amount of microporosity obtained in the casting. The importance of some of the factors

Fig. 6—Radiographs of section of turret casting, ASTM-4 alloy, are representative of regular production of this part in this commercial foundry. Height of sound metal in a wedge poured from same heat was only $\frac{3}{8}$ in. Compare with Fig. 7.

encountered in the melting practice which influence the amount of gas absorption is illustrated by the data in Table 4.

The good fluxing practice consisted of dusting the refining flux on lightly while stirring the melt, or permitting the refining flux to liquify completely before it was stirred into the melt. The poor fluxing practice consisted of placing about $\frac{1}{4}$ in. of refining flux on the melt and stirring it in before it was melted, this practice being quite common in commercial foundries.

The manner in which the refining flux is stirred into the melt is very important because the commercial fluxes contain up to 10 or 15 per cent and rarely less than 4 per cent of water. The fluxes are also strongly deliquescent and may absorb considerable water if the flux containers are permitted to stand open in the melting room for any length of time.

It is a characteristic of these fluxes that considerable water may be absorbed, even at slightly elevated temperatures, with the flux still re-

Table 2
EFFECT OF HYDROGEN ON OCCURRENCE OF MICROPOROSITY

Heat No.	Treatment of Melt	Height of Sound Metal in Wedge, in.	Grain Size, in.
82A	Melted, using good practice	3 $\frac{3}{4}$	0.005
B	Tank H_2 bubbled through melt at 1400° F. for 5 min.	0	0.004
83A	Melted, using good practice	3 $\frac{1}{8}$	0.007
B	Tank H_2 bubbled through water, then into the melt at 1400° F. for 5 min.	0	0.004
97A	Melted, using good practice	2 $\frac{9}{16}$	0.012
B	Dried H_2 bubbled through melt at 1400° F. for 5 min.	3 $\frac{1}{2}$	0.010

maintaining dry and powdery. It is only when very large amounts of water are absorbed that the flux cakes up or feels damp. If the fluxes are stirred into the melt before they have an opportunity to dry out on the melt surface, or if the melt is poured through a layer of flux, the moisture so introduced into the melt will gas the metal.

In addition to the (1) moisture in the flux, there are, of course, other sources of moisture which may gas the melt, these being (2) moisture on the surface of the metal charge, (3) moisture on the surface of tools and pots if they are not preheated sufficiently, particularly if they are covered with flux, (4) moisture naturally occurring in the atmosphere, (5) moisture from the products of combustion, and (6) atmospheric moisture which contacts the melt during the pour or that which is in the sand and contacts the liquid melt before solidification occurs.

No difference has been noted in the occurrence of microporosity in the wedge or in 5/32-in. plates cast in green sand or core sand. Both sands have A.F.A. permeabilities in excess of 100, and the moisture content of the green sand was about 2 per cent. However, unsoundness similar to ordinary microporosity is frequently found in fairly heavy sections near the surface adjacent to

Fig. 7—Radiographs of same section of turret casting shown in Fig. 6 when made from chlorine-fluxed metal. Improved soundness of this metal over that shown in Fig. 6 is obvious. Height of sound metal in wedge poured from same heat was 3 1/2 in.

Table 3
EFFECT OF OTHER SOURCES OF ATOMIC HYDROGEN ON OCCURRENCE OF MICROPOROSITY

Heat No.	Treatment of Melt	Height of Sound Metal in Wedge, in.	Grain Size, in.
81A	Melted, using good practice	2 3/4	0.012
B	Nitrogen bubbled through water, then in the melt at 1400° F. for 5 min.	1 1/2	0.010
85A	100 per cent scrap melted using good practice, except scrap was not dried	1	0.006
B	0.25 per cent zirconium hydride added at 1400° F.	0	0.008
86A	Melted, using good practice	3 3/8	0.006
B	0.28 per cent titanium hydride added at 1400° F.	9/16	0.007
87A	Melted, using good practice	2 1/8	0.020
B	0.25 per cent calcium hydride added at 1400° F.	1/8*	0.045
89A	Melted, using good practice	2 3/4	0.020
B	Steam bubbled through melt at 1400° F. for 5 min.	1/4	0.012
93A	Melted, using good practice	3	0.012
B	NH ₃ bubbled through melt at 1400° F. for 5 min.	1/4	0.015
100A	Melted, using good practice	3 15/16	0.007
B	NH ₃ added while heating from 1300 to 1600° F.	13/16	0.006

*See this specimen, 87B, Fig. 5.

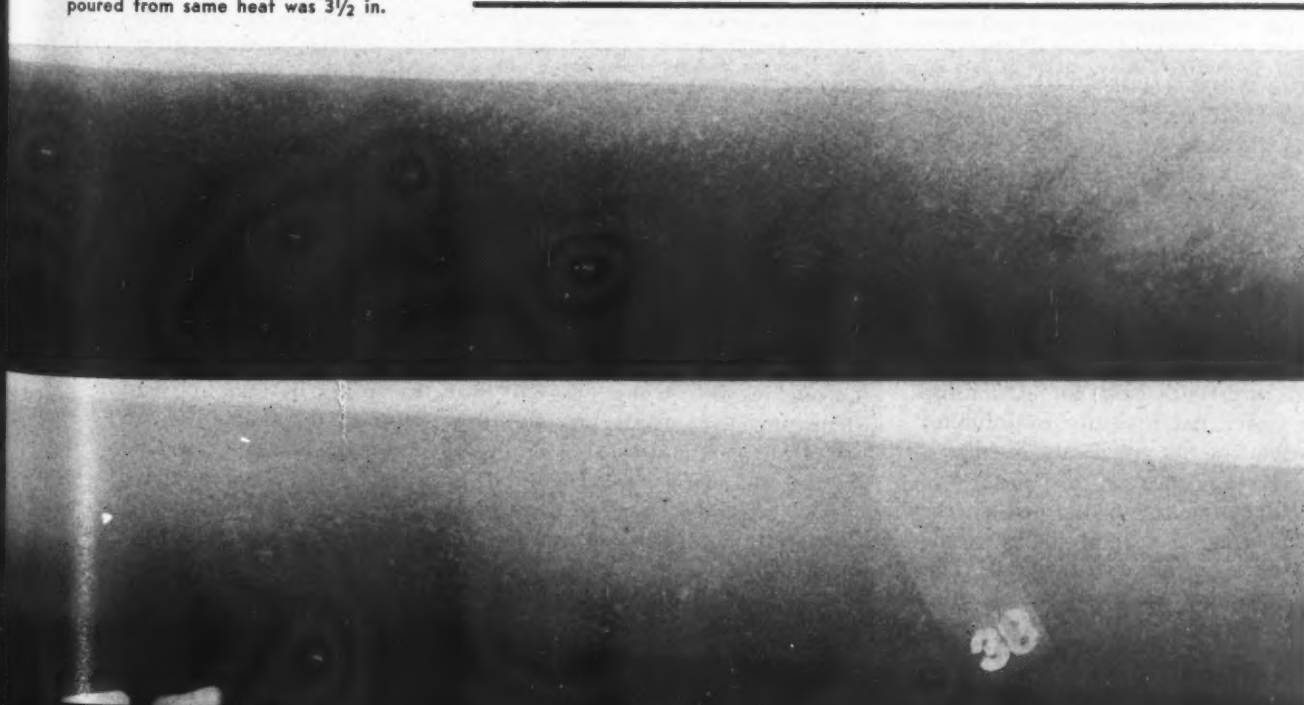
Table 4
EFFECT OF MELTING PRACTICE ON OCCURRENCE OF MICROPOROSITY

Treatment of Melt	Number of Melts	Height of Sound Metal in the Wedge, in.		
		Min.	Avg.	Max.
Good melting and fluxing practice	34	1 1/2	2 3/4	3 15/16
Poor fluxing practice	8	0	3/4	1 3/4
100 per cent scrap, good melting practice	4	1 7/8	2 7/8	3 1/2
100 per cent scrap, not dried, but otherwise good melting practice	4	1/4	1 1/8	1 3/4

either green sand or core sand (Fig. 12).

This possibly is caused by local hydrogen absorption and reprecipitation without general diffusion throughout the casting. If so, this hydrogen probably originates by the oxidation of the metal by the moisture or other oxidizing materials

in the sand, the latter occurring especially in core sands. This oxidation should be associated with sand reaction or burning, accompanied by the liberation of hydrogen which is locally absorbed and reprecipitated, forming microporosity as described elsewhere. Consequently, this surface microporosity should be accen-



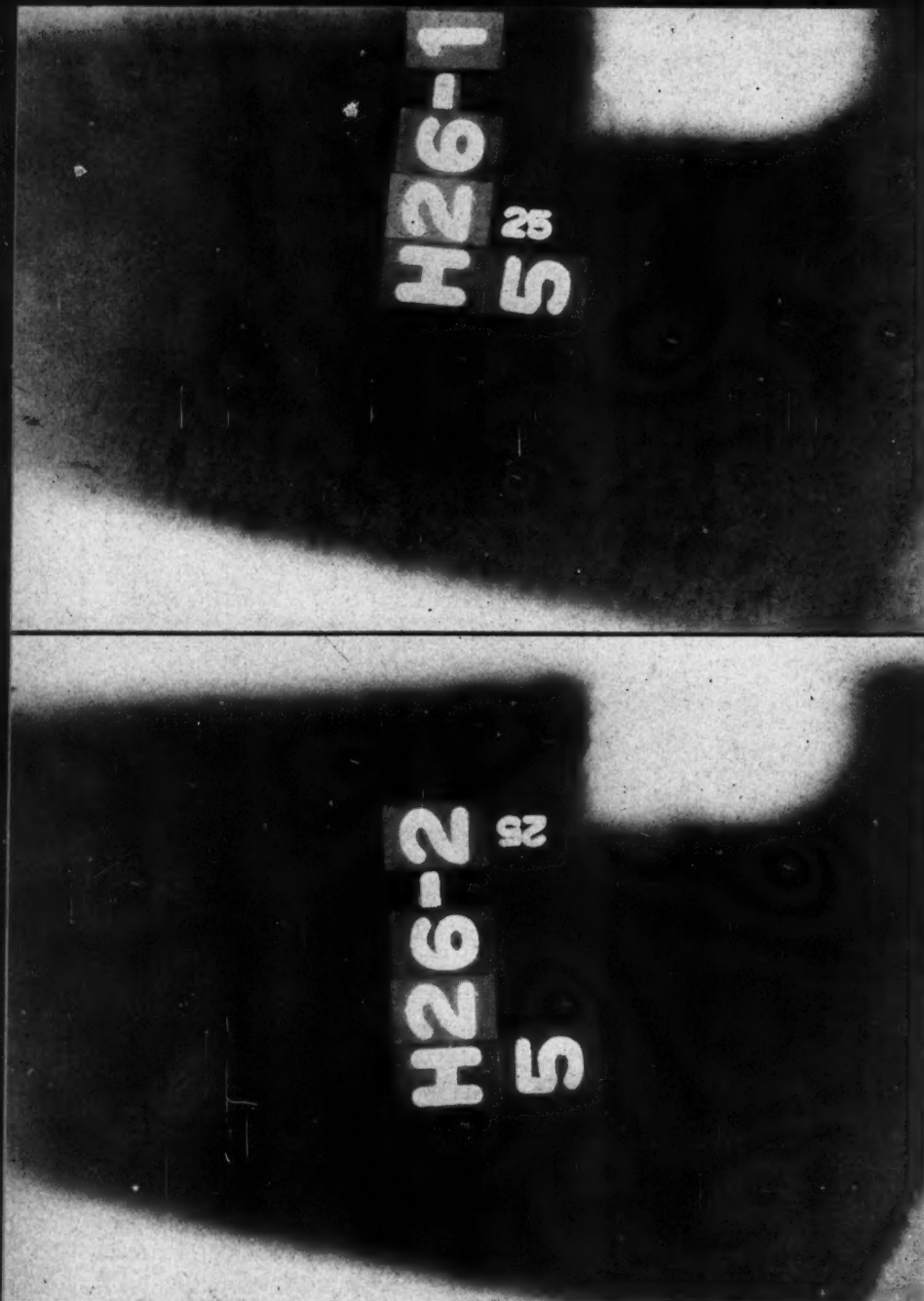


Fig. 8—Radiographs (Figs. 8 and 9) show microporosity in a gear housing, ASTM-17 alloy, and are representative of regular production of this aircraft part in a second foundry. Fig. 9—ASTM-17 alloy. Same as part shown in Fig. 8 except that metal was fluxed with Cl_2 . Reduction in microporosity effected by cleaning and degassing operation is evident.

tuated by high pouring temperatures, heavy sections, low inhibitors, and high moisture content of the sand.

Several experiments have been made, but it has been found that the occurrence of the microporosity in the wedge adjacent to the sand surface apparently bears no relationship to either the moisture or inhibitor content of the green sand used.

The moisture on the surface of the metal may be absorbed on the surface or as part of the corrosion products on the ingot or scrap. This is an important gas source which

can be avoided, partially at least, by the following practice:

(1) By not permitting corrosion to occur on the scrap or ingot, this being effected by proper housing and by avoiding long storage periods.

(2) By preheating the charge thoroughly, this being effected by preheating the metal to 400 or 500° F. in a separate oven, or preheating the metal carefully on the furnace edge and charging each addition onto that previously charged but which is not yet melted.

The data in Table 4 clearly show

the reduction in microporosity effected by preheating the scrap metal used in the charge.

The application of good safety rules requires preheating of pots and tools before they are permitted to come in contact with liquid magnesium, so that this gas source is not important. Gas absorption by permitting the melt to fall in a thin stream through the atmosphere is quite possible, but it can be avoided by keeping the ladle lip near the pouring box and pouring rapidly.

The moisture in the atmosphere, either that in the products of combustion in the gas or oil-fired furnace or that naturally occurring in the atmosphere, is difficult to avoid. A degassing operation after melting is about the only solution to this problem but, as the foregoing data indicate, a considerable reduction in microporosity can be effected by good melting and fluxing practices.

Removal of Hydrogen from the Melt by Using a Fluxing Gas

While good melting and fluxing practices are markedly beneficial in respect to the reduction of microporosity, it has been found that consistently better melt quality can be attained by combining good melting and fluxing practices with a degassing treatment, either coincident with or just preceding the grain-refining treatment. If superheating is used, this operation must follow the degassing treatment.

A common method of degassing melts, particularly those of aluminum-base alloys, consists of bubbling a suitable gas through the melt. While the action of such a gas may be in part chemical, it is probable that such a fluxing material acts as a mechanical carrier, the dissolved gas in the melt "desorbing" on the bubble of fluxing gas, the latter then carrying it to the melt surface where it can escape. Suitable fluxing gases for aluminum are chlorine, nitrogen, helium, and vapor from many solid and liquid materials, particularly chlorides.

Some of the results obtained by degassing by bubbling various gases through the magnesium ASTM-4 alloy melts are listed in Table 5.

In addition to the treatments listed in the foregoing data, SO_2 and sulphur vapor were tried, but they did not show much promise. Likewise, certain dried carbonaceous

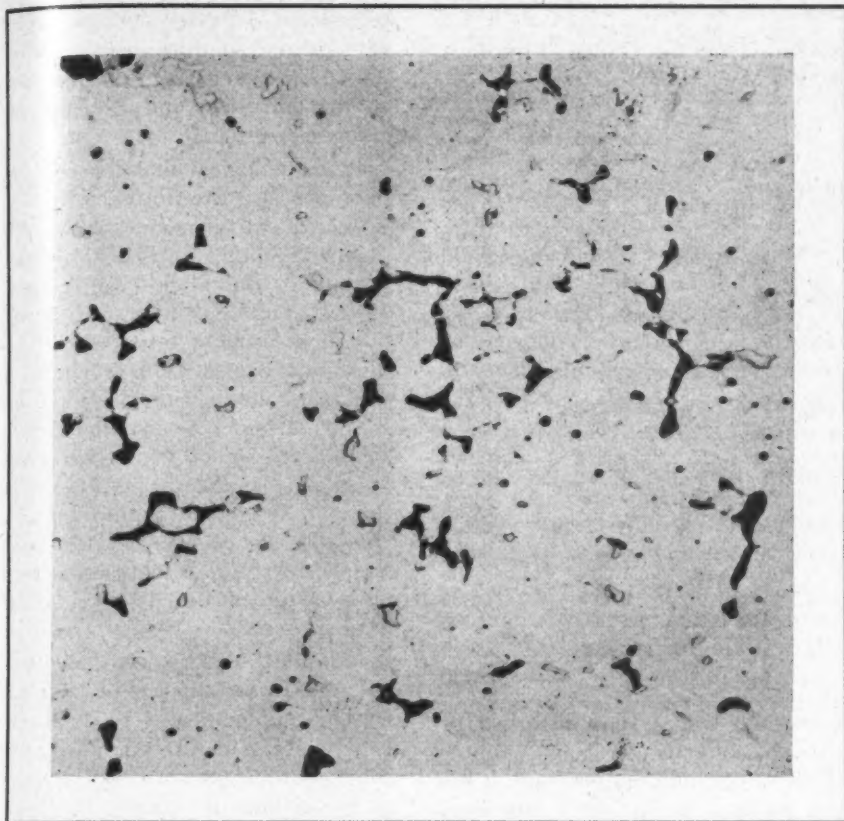


Fig. 10—Photomicrograph showing typical microporosity in ASTM-4 alloy casting. Magnification, X100.

gases, such as acetylene, CO_2 , and natural gas were tried and, while they do not show much promise as degassers, they have a beneficial effect, as reported separately.⁸

The data in Table 5 show that dried gases such as argon, helium,

and nitrogen do not show much promise, while a chlorine treatment has a markedly beneficial effect. The chlorine is used in place of the usual "cleaning" operation of stirring in a refining flux.

When chlorine is used, the metal

is melted, employing the usual melting flux, then chlorine is passed through a carbon tube into the melt for 15 min. at a rate such that the melt temperature during the chlorine treatment may be 1250 to 1450° F. Some slight burning may occur during this operation, particularly if the melt temperature is 1400° F. or above, but this is readily eliminated by a light sprinkle of refining flux.

The previously outlined procedure for the use of chlorine has been adopted as standard practice in all the experimental work, and scores of melts so treated have amply confirmed the reliability of the data on chlorine treatments listed in Table 5.

Commercial Foundry Tests

The laboratory results on the use of chlorine have been checked in two commercial foundries making aircraft parts. Several melts weighing up to 300 lb. were treated; in one foundry, wedges and miscellaneous aircraft parts were poured from melts (1) fluxed for 15 min. with chlorine, (2) melted using the melting precautions outlined previously, and (3) prepared by regular production methods.

In the second foundry, chlorine-fluxed and regular production melts were poured into aircraft parts, and quality comparisons were made. In each instance, the laboratory results were verified and typical radiographs of castings from regular production and chlorine-fluxed metal are shown by Figs. 6 to 9, inclusive.

Some concern was felt over the possibility that the MgCl_2 formed by the chlorine might cause flux inclusions. This chloride apparently separates from the melt very well, and no flux inclusions could be noted on the aircraft parts placed in a humidity room for several days.

A second common method of degassing aluminum alloys consists of melting, solidifying either in the pot

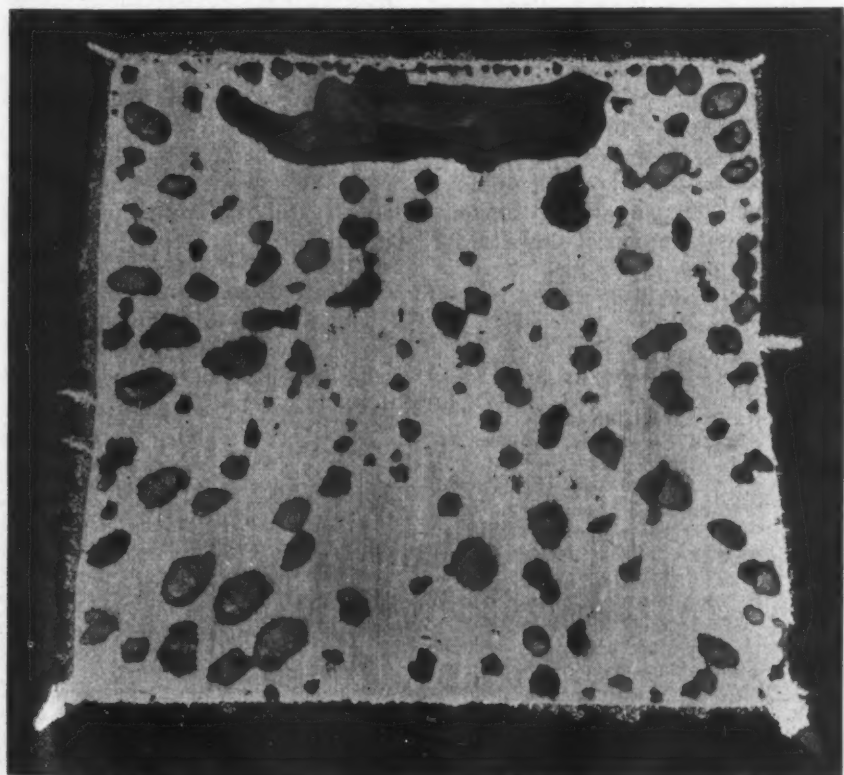


Fig. 11—Photograph of section of 4-in. cube, no riser, poured from ASTM-4 alloy melt which had been severely gassed with CaH_2 . Large cavities formed by hydrogen precipitated when melt solidified are ample evidence of the considerable hydrogen solubility in magnesium melts.

Table 5

REDUCTION OF MICROPOROSITY BY BUBBLING VARIOUS GASES THROUGH 40- TO 60-LB. MELTS OF ASTM-4 ALLOY

Heat No.	Metal Treatment	Height of Sound Metal in Wedge, in.	Grain Size, in.
80A	100 per cent scrap, melted using good practice	3	0.020
B	N ₂ from tank bubbled through the melt 5 min. at 1400° F.	2 1/2	0.030
96B	Melt gassed with zirconium hydride	1/8	0.010
C	Dried N ₂ bubbled through the melt at 1400° F. for 5 min.	3/16	0.015
99A	100 per cent scrap	1 13/16	0.010
B	Dried argon bubbled through melt at 1400° F. for 5 min.	1 3/8	0.007
106A	ASTM-4 alloy without Mn	1/4	0.008
B	Dried helium bubbled through melt at 1400° F. for 5 min.	0	0.008
133A	100 per cent scrap, poor fluxing practice	1/2	0.010
B	Dried helium bubbled through melt at 1400° F. for 5 min.	1 1/4	0.004
C	Melt superheated, commercial practice	1/2	0.008
84A	100 per cent scrap	1 3/8	0.007
B	Cl ₂ from tank, bubbled through melt at 1400° F. for 5 min.	2 7/8	0.006
100B	Melt gassed with NH ₃	1/2	0.006
C	Cl ₂ bubbled through melt at 1300° F. for 5 min.	13/16	0.006
115A	100 per cent new ingot, poor fluxing practice	1/8	0.010
B	Cl ₂ bubbled through the melt at 1400° F. for 6 min.	1 3/4	0.005
125A	100 per cent scrap, poor fluxing practice	0	0.007
B	Cl ₂ bubbled through the melt at 1400° F. for 15 min.	3 1/2	0.006

or by pigging the melt and then remelting. The decrease in solubility during solidification causes the precipitation of hydrogen in the form of H₂, which is not readily reabsorbed. If the conditions are such during the remelting operation that gas absorption is avoided or reduced, some degassing can be effected. The results of some laboratory tests are shown by the data given below in Table 6.

The foregoing data indicate that, under these conditions of melting, some decrease in microporosity can be effected by presolidification. Many foundries use this method to degas the gassy melts sometimes encountered when remelting poor quality scrap. In such instances, the high gas content will cause a high convex set on top of the risers, as is shown by the data on specimen 87B of Fig. 5.

The effects of pouring temperature, superheating, and grain size on the degree of microporosity have been investigated in the wedge castings and in horizontally cast plates. It has been found that very low pouring temperatures tend to accentuate microporosity, while wide variations in the normal pouring range have no noticeable effect on the amount or distribution of this defect.

Although the hydrogen solubility increases with increasing temperature, it has been found that the superheating operation does not accentuate microporosity, probably be-

cause the melt is not disturbed or exposed directly to a gas source while at the high temperature, it being encased in its oxide envelope. On the other hand, there is some evidence that a marked decrease in grain size reduces the susceptibility to microporosity to a slight extent.

Mechanism of Microporosity Formation

The role of gas in the formation of microporosity seems well established, particularly so since experience has shown a similar relationship in other solid solution types of alloys of different base materials.⁸ A general description has been made⁴ of the mechanism of the formation of microporosity, and the effects of (1) range in the temperature of solidification, (2) the amount of eutectic liquid solidifying at constant tem-

perature, (3) the temperature gradients during solidification as determined by the gating, risering, and chilling practice, and (4) the gas content of the melt.

It seems logical that the voids of microporosity are initiated by the shrinkage or contraction of the melt during solidification of the latter portion of the liquid. These voids would normally be filled with liquid, but in the solid solution alloys, the mushy zone makes this difficult. If the melt contained no gas, the voids would be under a vacuum, the absolute pressure of which would be equal only to the vapor pressure of the melt at the temperature in question. If this were true, the voids would draw liquid metal into them as a result of the exterior atmospheric pressure.

However, if the melt contains a gas in solution which is precipitated during solidification, as is usually the case, these voids are gas filled, and this condition prevents the entrance of metal into the voids. This condition is akin to that existing when trying to pour a liquid into a narrow necked bottle. Microporosity, then, may be regarded as being initiated by shrinkage, but the gas in the metal may prevent the resulting voids from being fed.

On the basis of the foregoing remarks, and on those cited in Reference 4, it is evident that microporosity can be reduced by effecting the following conditions:

(1) Reducing the gas content of the melt.

(2) Steepening the temperature gradients toward the risers by using good gating, risering, and chilling practice.

Table 6

EFFECT OF PRESOLIDIFICATION ON OCCURRENCE OF MICROPOROSITY IN THE WEDGE CASTING

Heat No.	Metal Treatment	Height of Sound Metal in Wedge, in.	Grain Size, in.
76A	New ingot, as melted	2 3/4	0.015
B	"Cleaned" with No. 310 flux	2 3/8	0.010
C	Solidified in the pot and remelted twice	2 3/8	0.008
D	Superheated	3 1/2	0.004
77A	100 per cent scrap, as melted	2 1/2	0.005
B	Ingoted and remelted	2 7/8	0.008
78A	100 per cent new ingot, as melted	1 7/8	0.025
B	Ingoted and remelted	3	0.007
101A	100 per cent scrap, "cleaned" with No. 310 flux	2 3/8	0.008
B	Solidified in the pot and remelted twice	2 7/8	0.012
56	Melted, solidified in the pot and remelted twice under a No. 230 flux	3	.....



Fig. 12—Radiograph of wedge casting section showing microporosity at the edge next to the green sand. This is not uncommon in heavy sections of magnesium alloys cast in green or dry sand, and probably represents local absorption of gas generated as a result of initial stage of sand reaction.

(3) Using an alloy composition which will be least susceptible to microporosity.

Only the first of these has been described in this paper, the second encompasses the entire gating problem; a discussion of which has not been attempted, while the third part has been covered as a part of a separate paper.⁵

Summary

Extensive laboratory tests checked by production foundry results have clearly shown that, all other factors being the same, microporosity in magnesium alloy castings is markedly reduced by degassing the melt and greatly increased by exposing the melt to any condition which produces atomic hydrogen. The most

common source of atomic hydrogen is moisture, and the common sources of moisture are listed in their probable order of decreasing importance as follows:

- (1) In the flux.
- (2) Absorbed on or in chemical combination with the metal surface as part of the corrosion products.
- (3) In the surrounding atmosphere, either in the products of combustion or naturally occurring in the atmosphere.
- (4) In the atmosphere or in the sand and absorbed during the pour and before it solidifies in the mold.
- (5) On pots and tools not thoroughly preheated and which come in contact with the melt.

The methods of reducing gas absorption from some of these sources during melting are described. The best method found for degassing and removing dross from the melt is by fluxing the melt with chlorine instead of performing the standard "cleaning" operation with a refining flux. Presolidification was also found to be beneficial, although slow and uneconomical.

Acknowledgment

To the Office of Production Research and Development of the War Production Board, which sponsored the work described in this paper and granted permission for its publication, to the Office of Scientific Research and Development, which guided the work, to members of the Advisory Committee on Project NRC-546, and to many members of the staff of the Battelle Memorial Institute, especially Messrs. C. H. Lorig, C. T. Greenidge, and A. R. Elsea for their valued assistance, the authors gratefully express their thanks and appreciation.

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• COMMITTEE REPORT

Brass and Bronze Plans Present and Future Work

By Chairman B. A. Miller,
The Baldwin Locomotive Works,
Philadelphia, Pa.

THE A.F.A. Brass and Bronze Division during 1944 made some real progress! A conscientious effort was made with satisfactory results, to attempt to interest the younger element in the division.

A new committee on the Microstructure of Brass and Bronze Alloys, headed by Dr. B. M. Loring, was appointed to study and correlate the relationship between the microstructure of brass and bronze alloys and their physical properties. A great wealth of information will be forthcoming from this committee as the microstructure data is accumulated.

Participation Invited

Brass and bronze foundrymen have always needed this information, and although it may be a few years before a great deal of this information can be gathered and correlated, we feel this to be a step in the right direction. We invite active participation from all foundries engaged in non-ferrous practices.

A committee on Casting Processes for Brass and Bronze also has been appointed, consisting of: Recommended Practices on Centrifugal Castings; Recommended Practices on Die Castings; Recommended Practices on Permanent Mold Castings; Recommended Practices on Precision Refractory Molding; Recommended Practices on Investment Castings and Recommended Practices on Cement Mold Castings.

New Data Expected

Able chairmen have been appointed for these various committees and we can expect fast information forthcoming pertaining to above practices.

In 1944 we also published a book on "Recommended Practices for the Sand Casting of Non-Ferrous Alloys," and from the favorable comments I have received this book will take its place with the outstanding publications of the American Foundrymen's Association.

It is our aim to bring all non-ferrous operators all the informa-

tion that we can acquire to make him do a better job. This can only be done through the generous co-operation of all brass and bronze foundrymen.

Moldenke Collection Added to TDP Library

THE American Foundrymen's Association recently received from Mrs. Richard Moldenke the complete technical library of her late husband, Dr. Richard Moldenke. These volumes were donated by Mrs. Moldenke as a memorial to her husband, who was secretary and treasurer of the American Foundrymen's Association during its early formation.

Dr. Richard Moldenke became interested in foundry and metallurgical work while employed in Pittsburgh and joined the American Foundrymen's Association in 1897. From 1900 to 1914 he served as secretary and treasurer of A.F.A. During his last few years, while continuing his technical society activities, Dr. Moldenke acted in an advisory capacity to a large number

of foundries and manufacturing firms both in this country and abroad. He was a prolific writer on foundry and metallurgical subjects from 1897 until his death in 1930. His writings are still used as reference.

The addition of Dr. Moldenke's library to the many volumes accumulated by A.F.A. will add much in the way of foundry knowledge and information to the library being organized and developed by the Technical Development Program.

• COMMITTEE REPORT

Mechanical Standards Is Performing Many Tasks

By LeRoy M. Sherwin,
Brown & Sharpe Mfg. Co.,
Providence, R. I.

THE Mechanical Standards Committee serves as the general advisory and correlation committee of the American Standards Association in the mechanical field. This includes the establishment of American Standards and the international cooperation in standardiza-

tion work. The committee also considers what subjects are appropriate for development in the American Standards Association; defines and limits the scope of projects; recommends sponsors; follows up work in progress in the development of projects; reviews the personnel of committees responsible for projects to insure their representative character; examines recommendations submitted by sectional committees; harmonizes conflicts; and performs such other functions on behalf of the Standards Council as assigned.

Over the years, a variety of standards have been approved by this committee and work has been done on many more. Some of these which apply to the casting field are as follows: Cast iron pipe flanges and flange fittings; malleable iron screwed fittings; cast iron long turn sprinkler fittings; cast iron screwed drainage fittings; steel castings specifications; pressure ratings for cast iron pipes, flanges, and flanged fittings; proposed revision of American standard specifications for alloy steel castings; and valves, flanges, and fittings for service at temperatures from 750 to 1100° F.

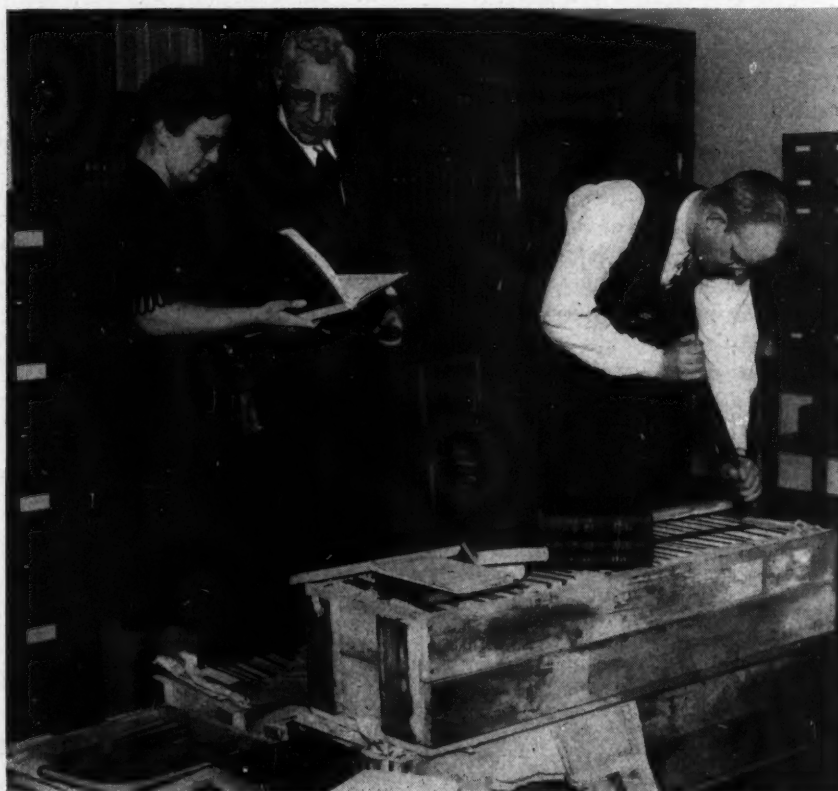
From the standpoint of the American Foundrymen's Association, the above standards are more specific than general. However, to the recipients of this information, the Mechanical Standards Committee has a place which it fills with considerable success.

Frank Wartgow Assumes New Engineering Position

FRANK E. WARTGOW, vice-president elect, Chicago chapter, has resigned his position as Supervisor of the Suggestions Systems, American Steel Foundries, Chicago, to become Supervising Engineer with Hasbrouck Haynes, Engineers, 38 So. Dearborn St., Chicago.

Mr. Wartgow has been active in the affairs of the Association for many years, serving as Chairman of the Committee on Time Study and Job Evaluation, and at present as Chairman of the Foreman Training Committee. He has been active in the work of the Chicago chapter and its committees, for the past several years serving as secretary prior to his election as vice-president.

AMERICAN FOUNDRYMAN



Looking over one of the many editions belonging to the late Dr. Richard Moldenke are Fannie Hall, A.F.A. editorial assistant, and Bob Kennedy, secretary, A.F.A. Norm Hindle, director, Technical Development Program, completes the job of opening the last box of books.

• A method for controlling sands by elevated temperature tests is being used by the author's company. Securing a good base sand and using the hot compressive strength test at 2000° F. forms the basis for the preparation and maintenance of a sand mixture suitable to any specific job. The balanced base sand is chosen from the results of "spall" tests, after which hot compressive strength values lying within a definite range are maintained in the ensuing sand mixture by means of clay manipulation. Use of this method results in reduction of scrap losses due to scabs and sand inclusions.

Elevated Temperature Tests in SAND CONTROL

By Arnold Satz, Metallurgist,
The National Radiator Co., New Castle, Pa.

WHILE elevated temperature work with foundry sands has had a start within the industry, it has only recently crossed thresholds into the realm of practical sand control. The elevated temperature testing furnace has proved invaluable in revealing certain aspects of sand behavior at high temperatures. But still greater benefit may be expected as the device is applied to the control of daily sand preparation and reduction of scrap losses.

A practical method for elimination of scabs and sand inclusions in castings, as used by the author's company, will be described in succeeding pages.

Two Phases of Testing

Before a new sand becomes acceptable for application as the base material in sand mixtures for a specific job, its ability to withstand any hardship may be determined by studying the characteristic behavior of the material at elevated temperatures. Once this ability is ascertained, the second phase of testing with the elevated temperature furnace, maintaining a specific balance in the mixture, would give uniformly satisfactory casting results. This is accomplished by means of routine testing and adjustments.

Refractoriness, admittedly a very important quality in good sands, may be roughly determined in the

elevated temperature testing furnace. Although this method is not nearly as sensitive as the present common procedure where a specimen is tested with a sintering meter, it offers a rapid check and an easy basis for comparison when choosing from among different new sands or mixtures.

Briefly, the adhesion of sand grains to one another after the specimen is subjected to a temperature of 2500° F. for 12 min. is the basis for judging refractoriness. Some samples of sand have been found to be hard, others could be crushed in the hand, after being submitted to this test. With intermediate degrees of incipient fusion being shown by scratch tests, the method does present a means for comparing sands or mixtures.

Besides being refractory in nature, the sand under consideration must resist spalling or cracking at elevated temperatures. In this determination, a green sand specimen is inserted into the elevated temperature testing furnace heated to 2500° F. Inspection is made after 2 min. to determine whether cracking occurred on expansion, and after 12 min. to observe whether spalling resulted due to both expansion and contraction. This test requires the use of two different specimens, one for each observation.

Nearly every foundryman is acquainted with Dietert's¹ example of

a scab-forming sand. He has introduced the assumption that during the contraction cycle, a thin layer of sand buckles out into the molten metal filling the mold cavity. Where metal is able to slip behind the buckled sand a scab is formed, with the common metal-sand-metal sandwich effect resulting.

Scabs most commonly occur on flat sand surfaces, which readily act in the manner described. In a round section or one of uneven surface, any sand buckling would not readily produce a perfect bridge. It seems logical to assume that in this case a "peeling" of the outer sand skin would present a weak projection easily eroded by a moving stream of iron, and that sand particles would be carried into the mold cavity. In this way, a sand wrongly applied would give scabs to some castings, and impart dirt inclusions to those castings which were not readily apt to scab.

Cracking and Spalling

The elevated temperature testing furnace may either underestimate or overemphasize the seriousness of cracks and spalling in a specimen. A close sand used in radiation molding spalled badly in the testing furnace. Specimens were seen with bridged outer skin, or skin rolled back in the fashion of an orange



peel. Yet for light radiation work this sand gave only dirt-bearing castings, because a high hot strength was never developed in the sands on pouring. Sands used for heavy boiler work were similarly tested and found to have minor cracks; these sections bore scabs.

In correcting both sands, serious spalling in test specimens of the first was cut to a cracking state and dirt losses were reduced. When cracks were eliminated from boiler sand test specimens, scabs became fewer.

Balanced Sand Mixture

This behavior of sand specimens calls for careful analysis of any condition of cracking or spalling indicated by this test. The extent to which a sand specimen may crack before trouble can be expected with castings should be established by close relation of test and casting results.

By a balanced sand mixture, the writer means one that has a fairly narrow grain-size distribution and is intensively mixed. Such a sand mixture would react uniformly under all stresses imposed by hot iron.

Summarizing, the author and his associates find it important to have a well-balanced new sand and, therefore, use this measure of sand control. It is made certain that the new sand in use or about to be adopted will behave correctly in the furnace for elevated temperature testing. The testing temperature chosen is closely related to the casting size, and to the tendency of the sand mixture to scab or to yield sand inclusions.

Previous to the use of sand testing, foundrymen determined the value of the sand by "cut-and-try" methods, finally settling on the method giving good results most of the time. New methods permit of picking the best sand, and then exacting consistently good results by means of laboratory control.

Furnace for Control Purposes

Once a balanced sand of desirable qualities is in use, a method of control is necessary to maintain these properties. The method outlined here has been in use for over a year, is easy to apply and the results have been gratifying.

In addition to the "spall" tests, three other principal sand tests are possible when using an elevated tem-

perature testing furnace. These are the expansion-contraction test, the hot deformation test, and the hot compressive strength test.

Throughout this paper, all reference to hot strength tests will imply the hot compressive strength test as opposed to other hot strength tests which may be in use or may be introduced later.

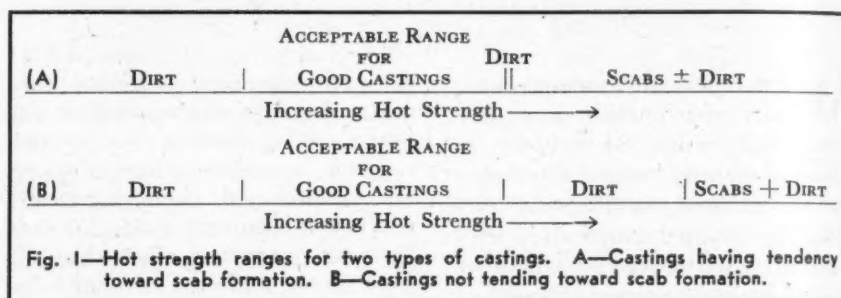
The importance of expansion and contraction in foundry sands has been emphasized by Dietert¹ and others. In applying results of elevated temperature tests in a practical way, however, this particular test leaves much to be desired. When the control method was first set up, it became clear that while expansion-contraction tests offered an insight into a sand's behavior, the test

that any other properties which are required of a good sand mixture be sacrificed.

Fields of Application

This laboratory has found that the use of hot strength tests in maintaining the same desirable properties in sands is a method applicable to the control of all moldings sands. The greatest benefits are secured for a continuous molding and sand system where constant testing with adjustment at the mixer is possible. For floor molding and special jobs, the method likewise is used in adjusting the properties of the sand so as to obtain results required for any specific type of work.

This method has been applied in control of sand mixtures used in



figures were not correlative with either scrap losses due to scabs or to sand inclusions. That it is difficult to change the expansion-contraction characteristics of the sand mixture is another reason for discarding this test.

Hot deformation, as a test, fell into disuse since, like the expansion-contraction test, it indicated behavior without showing a means for correcting adverse conditions. Besides, this test still lacks the accuracy essential in sand-control work.

Differing from the two foregoing tests is the hot strength determination. This type of test was found to be positively related to scab losses and losses due to sand-bearing castings. Use of this test for control is relatively easy and does not demand

skin-dried molding, and is more rapid than the tests using elevated temperature testing furnace specimens, the latter specimens being first oven dried.

Hot Strength in Use

Every casting made requires a hot strength which falls within a certain range of values. Below the minimum acceptable hot strength value in the range, the sand will be cut or washed and the castings will contain dirt inclusions. On exceeding the maximum point in the range, castings bearing scabs along with dirt, or scab-free castings with only sand inclusions will result.

This last condition depends on the casting shape and indicates a condition explained previously. Throughout the acceptable or suitable range of values, castings will be scab and dirt free. A diagrammatic representation of this phenomenon is presented in Fig. 1.

A number of factors influence the hot strength values lying within an acceptable range. These include

This paper was secured as part of the 1945 "Year-Round Foundry Congress" and is sponsored by the Foundry Sand Research Project, Technical Development Program of A.F.A.

green permeability, grain size, and method of gating.

To most foundrymen, permeability indicates the ease with which a sand vents mold-formed gases. Just as important, perhaps, is the function of permeability in venting heat. Observations made on sands at elevated temperatures have led us to believe that almost all defects resulting from a sand are due to the sand's behavior when heated rapidly by the pouring of hot metal.

Value of Permeability

A sand that spalls at 2500° F. may react satisfactorily at 2000° F. In another sense, the greater the ease of dissipating heat, the less will sand tend to form scabs. This function of permeability tends to broaden the

differ only because of a difference in grain size. Assume that good results are obtained with one of the mixtures having a hot strength of 80 psi. The second mixture, because of a coarser base grain, has a hot strength of 50 psi. but is to be used in broadening the range of acceptable hot strength values by its effect on permeability.

Since good results were obtained with the finer sand when the hot strength was 80 psi., the technician might think it advisable to add clay in order to raise the hot strength of 50 psi. in the coarser sand to the 80-psi. value of the finer sand. Scabs would no doubt result from this action, since consideration should have been given a lowering of the test results when the grain size was

ing within the acceptable hot strength range.

Collapsed Range

With an understanding of how the various factors tend to limit or to extend the range of acceptable hot strength values which give good casting results, it is possible to consider what happens when both scabs and cutting are found as defects on the same casting. The sand mixture giving this condition may be considered to possess no suitable hot strength range at all; that is, the range is collapsed since the particular mixture will not give good results no matter to what hot strength it is adjusted.

A lower hot strength attained in eliminating scabs would give a sand that might wash easily. A higher hot strength, achieved in order to eliminate wash, would give a sand producing scabs. A good example of this would be the use of a very fine sand for large castings. There is not much that can be done in making this sand work right.

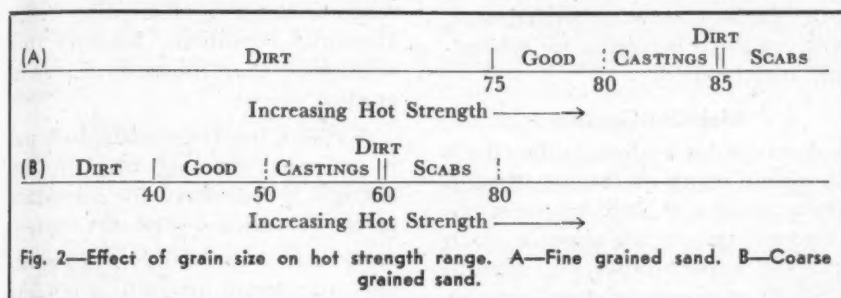
The solution to a collapsed hot strength range lies in making one or more of the following changes:

1. Change base or new sand so as to get a well-balanced mixture which will not spall.
2. Switch to a higher permeability by use of a coarser grained sand. This will spread the acceptable hot strength range. Permeability may be increased just enough to provide a range sufficiently wide for easy control and inclusion of a safety factor, but not so much that poor finish results.
3. Change the method of gating so as to eliminate concentration of stresses on areas giving trouble.

These corrective measures probably are not new, but the method of determining where the source of trouble lies might be. We have found that testing at elevated temperatures is a positive means for telling when a sand does not suit conditions imposed upon it, for indicating what changes are needed and the extent of the required changes.

Testing and Controlling Sand

Once a satisfactory base sand is in use, only the hot strength test is run for control work. The 1½ x 2-in.



range of hot strength values giving good casting results, and lessens the need for close control of moisture and clay content. Specifically, if good castings result when hot strength values range from 50 to 60 psi. at a permeability of 70, the range may extend from 45 to 65 psi. with an increase to 100 in permeability.

Many defects are guarded against when sands of very high permeability are used. However, modern practice demands closer attention to surface finish and imposes a restriction on the maximum permeability which can be maintained.

Although to the foundryman sand grain size and permeability are closely related, each requires different consideration in high temperature testing for hot strength. Dietert and Woodliff² have shown that hot strength changes with grain size.

Consider two sand mixtures having the same make-up with the exception that one has a finer base sand than the other. The hot strength values of these two mixtures will

changed. Changes of this sort require the establishment of an entirely new range of acceptable values.

Figure 2 represents this condition, showing that both sands could give good castings if used properly.

The example cited indicates that changes in size of sand grains affect the results indicated and that consideration must be given such factors as grain-size changes when interpreting test results.

Like consideration must be given any deviation from the temper moisture content in a test sample when determining the need for a change in clay additions.

Methods of Gating

One way of correcting scab formation and dirt inclusion lies in changing the method of gating. The hardship imposed on a sand by poor gating has the effect of limiting the range of acceptable hot strength values. Where conditions do not permit changes in a poorly gated casting, the burden of obtaining good castings is forced onto exacting sand control as a means of remain-

specimen, double-end rammed, is placed in the elevated temperature testing furnace without first being dried. All hot strength tests are run at 2000° F. without regard for pouring temperature. It has been found that hot strength test results can be correlated with casting results though almost any testing temperature above 1500° F. is used.

Application of Data

At 2000° F., so far as our experience goes, test results appear in a spread of values that permit easy application of data. This fact implies that results are sensitive enough to clearly indicate the effect of changes in moisture and/or clay content. In addition, values obtained at this temperature are not seriously affected by inaccuracies in the elevated temperature testing furnace, as those tests are run at much higher temperatures. The range of acceptable hot strength values at 2500° F. may be 1 or 2 psi., while at 2000° F. this range may be 10 to 20 psi.

All test specimens are compressed after a 4-min. recovery period plus 8 min. "at temperature" period. The hand-cranked hydraulic system is turned at the rate of 12 r.p.m. This rate was arrived at since it was found that a uniform motion could be maintained with the aid of a stop clock. Half revolutions of the crank correspond with 2½ and 5-second points of the sweep second hand. In this way, three operators at the author's plant are able to check each other closely.

Should test results indicate a hot strength other than that specified for a given job and sand condition, corrective measures are taken immediately. Three types of clay bonds are used in getting a desired condition—a western bentonite, a fireclay, and a southern bentonite. The procedure of effecting the changes outlined by Dunbeck³ closely resembles that followed by this laboratory.

Clay Bond Additions

In reducing a high hot strength, new bond-free sand is added, with southern bentonite being used in quantities sufficient to maintain the required green strength. For increasing hot strength, the western bentonite is used, while intermediate values are obtained with the fireclay.

The foregoing procedure is followed with both facing and backing sands whenever a change is needed.

Naturally-bonded sands used for re-bonding "floor" sand mixtures function as hot strength raisers and, while the quantities added can be adjusted to correspond with requirements as indicated by test, the ease of control is not equal to that possible when using a synthetic sand and clay additions.

In all cases, control is kept fluid, with correct hot strength values the goal for any change made.

The moisture content is kept at temper, but there may be cases where the moisture content is so high that it causes too great an increase in the hot strength. Where this occurs, southern bentonite may be substituted for western bentonite, or a mixture of new, unbonded sand, with southern bentonite for rebonding, may be used.

Moisture Content

A system for evaluating the effects of various bonds on the hot strength characteristics of sand mixtures has been set up. As an example, each quart of western bentonite added to 1200 lb. of facing mixture increases the hot strength (at 2000° F.) by about 9 psi. Cutting the hot strength of system (old) sand used in facing preparation is accomplished by adding a new, unbonded sand.

When the facing contains 25 per cent of new, unbonded sand, a reduction of 20 psi. is expected in the hot strength of the mixture. It is assumed that southern bentonite does not increase the hot strength by any significant amount. Thus this material may be used in maintaining proper green strength without affecting the hot strength.

Moisture is very effective in raising the hot strength of sands. In this fact lies the importance of close moisture control, if scabs are to be eliminated. Every attempt is made at keeping the moisture only at temper, but steps are taken to maintain a range of hot strength values sufficiently wide so that normal increases in moisture throughout the day will not cause hot strength values which might soar into the trouble zone.

Whereas these values would not exactly apply in other foundries, similar evaluations could be set up. Of importance is the fact that condi-

tions are maintained whereby changes may be made to compensate for any variation in the rate of "burning out" clay, or the rate of adding new sands to a system. Thus the elevated temperature testing furnace assumes the role of indicating needed changes, which can be made as conditions require and before difficulty is encountered.

Conditions relative to setting up the most suitable hot strength range have been considered. It has been found advantageous to inspect castings closely as soon as possible after shake-out to ascertain that the proper range is in use. Should scabs be found when sands are held in what is thought to be the proper range, and it is known that no "wet" streak of sand had been encountered, the maximum point of the range is lowered. Excepting under abnormal conditions, however, the sands have been found to change in gradual swings.

A reason has been established and is presented showing why the hot strength is considered the important factor in scab and sand-dirt control.

As stated previously, expansion and contraction in sands at pouring temperature are the conditions thought to cause sand spall, with resulting scabs or dirty castings.

Sand Embrittlement

It appears as though a sand becomes more brittle as the hot strength increases. Much as a brittle metal resists deformation, sand will not react to heat uniformly but will "give" even though hot shrinkage be of a magnitude so small as to be labelled satisfactory by an elevated temperature testing furnace expansion-contraction test. Thus, embrittlement decreases a sand's ductility at pouring temperatures.

That dirt inclusions due to a low hot strength result from a wash effect is a generally accepted fact.

To more clearly tie in hot strength with scab formation, one has only to consider what action was taken in the foundry with which the author is associated before introduction of this method. Generally, when scabs were found, first attention was given to moisture content. Since water is the most potent substance for increasing hot strengths, a reduction in hot strength accompanied

any cutting of the moisture content.

In cases where it was known that temper was not exceeded, another means of reducing hot strength⁴ (reduced ramming) was tried. Another way of lowering scab occurrence was found to be in effecting a reduction in green strength. This also meant cutting the hot strength by reducing clay additions.

Permeability often was increased as a solution to scab problems. Although not a means for reducing hot strength, it did extend the hot strength range so that were scabs to appear at a given value, the new permeability would extend the range and the given value then would be lower than the maximum allowable hot strength for defect-free castings.

Summary

Summarizing, casting losses due to scabs and dirt inclusions were reduced by adhering to the following procedure:

1. Choosing new base sands on the basis of spall tests.
2. Maintaining a hot strength range which will give good castings by correlating test results with casting results.
3. Maintaining desired hot strength value in the sand by continuous changes in clay additions

when the need for such changes is indicated by test results.

4. Adjusting the hot strength range when necessary by changes in the sand grain size.

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VISUAL INSPECTION Method Necessitates Serious Study

By M. D. Johnson,

Inspection of Castings Committee and Staff of the Director of Manufacturing, Graham-Paige Motors Corp., Detroit, Mich.

IN the preparation of a Manual, or Inspectors' Handbook, to be used in various foundries, certainly there is no phase of inspection that requires more serious study and consideration than visual inspection.

Visual inspection may be either normal inspection, where no tools—except good eyes—are required or it may be visual inspection supplemented by simple tools or methods. In the former case, where straight visual inspection is used, not being supplemented by any tools, many

types of defects can be discovered so that undesirable castings will not reach the ultimate purchaser.

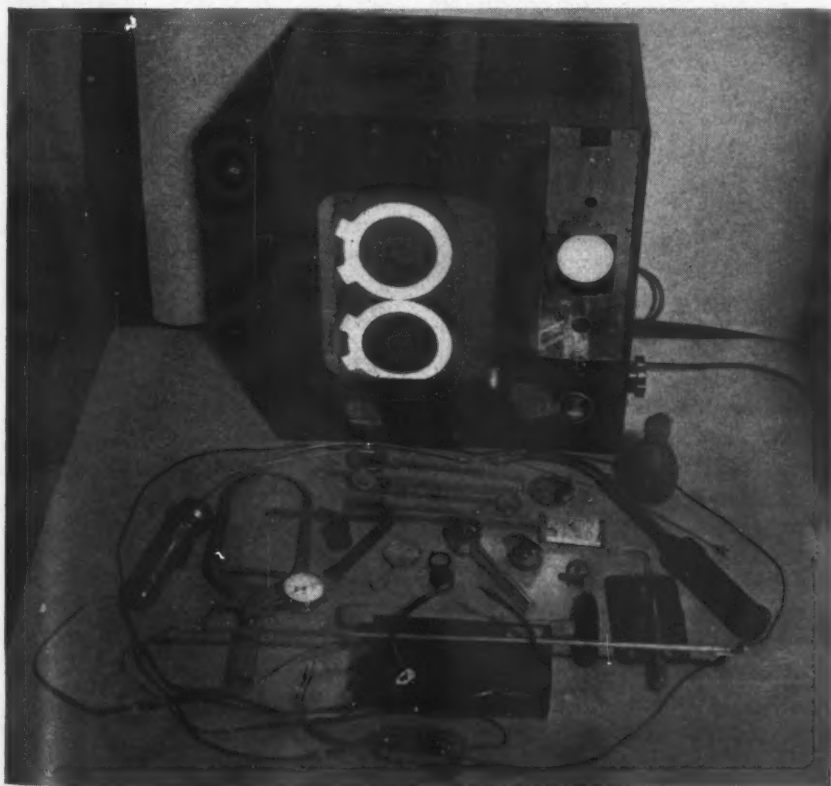
Machining Costs

Probably the first type of defect noted in visual inspection will be dirty castings, which may appear in several forms. An outstanding example is burned-in sand. This is particularly detrimental to a cutting when burning-in occurs on a machined surface. Even though such a condition may not diminish the value of the ultimate part, it may result in excessive machining costs due to a breakage of cutters.

Normal loose core sand and foundry dirt, if not properly removed from castings, render them unsatisfactory. This is especially true if sand or dirt finds its way into oil compartments where the oil used in the finished product can become contaminated by such damaging material.

Chipping Castings

Another type of defect connected with dirt is the case of improperly chipped castings. Unsatisfactory chipping is one of the most serious errors in some cleaning rooms. It is very critical in the case of cylinder blocks where fins are not properly removed, and where vibration may result in the fin breaking off



Shown are various types of tools needed for visual inspection of castings, namely, adjustable mirrors, search light, magnifying glasses, metal thickness calipers and viewing screen.

and causing considerable damage.

Sand holes, gas holes and shrinks are additional defects which are easily discovered by straight visual inspection, if the inspector is alert at all times.

Although this summary dealing with straight visual inspection is necessarily brief, it should not minimize the value of such inspection, which may be the means of rejecting many castings which otherwise would reach the purchaser.

A slightly advanced stage of visual inspection is where normal eyesight is supplemented by simple tools. One important example is the use of tag wire, which is generally found in all foundries and manufacturing organizations. Many times, particularly on steel castings, an inspector may observe what appears to be a small hole that does not seem sufficiently important to cause a rejection. However, if a piece of tag wire is inserted in this hole it may be found that there is a very large sub-surface cavity.

Final decision on such a condition should be made after sectioning the casting. It may be surprising to learn, once the casting has been sectioned, how valuable this simple inspection operation can be.

Another simple tool is the pointed hammer, which an inspector should have with him at all times. Slight indentations in castings, if pounded with the pointed hammer, may reveal serious sub-surface defects. It should be emphasized, however, that care should be exercised in this method of inspection, particularly with gray iron, as a perfectly good casting may be rendered unusable through breakage.

In the case of certain castings, where there is a tendency toward warpage, the accuracy of a casting may be determined by the use of the straightedge or a flat surface.

An ordinary hand file often can be used with surprisingly good results to locate hard and chilled castings. A file is extremely valuable in the inspection of gray and malleable iron castings and of steel castings which have been improperly salvaged by welding.

This brief summary on visual inspection would not be complete without calling attention to the valuable use of chalk and oil as a means of supplementing visual inspection for

cracks in castings. Here again this method can be especially useful in gray iron castings inspection. It must be recognized that gray iron castings are the most easily broken. I am sure that if the chalk and oil method were used more extensively by foundry inspection organizations — and certainly every foundry must know how this operation is performed — fewer broken castings would reach the purchaser's plant. Considerable controversy is apt to arise over castings received broken. The result is bad feeling between the vendor, the carrier and the purchaser. I am positive that the chalk-and-oil inspection would prevent shipment of many broken castings, to the advantage of all concerned.

Many other types of inspection will be covered in "AMERICAN FOUNDRYMAN" by members of this committee. However, it is felt that in all probability seventy-five per cent of the defective castings could be thrown out at the foundry by vigilant inspectors if they would take advantage of these suggestions made in the interest of visual inspection.

Twin City Men Organize Chemical Analysis Group

THE recent publishing of certain methods of analysis, useful in the foundries, in the publications of your Association has led to the formation of a Committee on Chemical Analysis by a group of interested individuals in the Twin City chapter area. The committee has been formed under the chairmanship of H. F. Scobie, Instructor in Chemistry, University of Minnesota, Minneapolis, and formerly Instructor in Foundry Practice at that institution. Other members of the Committee are: Fred Boxemeyer, Northern Malleable Iron Co., St. Paul; Ben J. Grimm, Twin City Testing & Engineering Laboratory, St. Paul; Carl Johnson, Minneapolis Electric Steel Castings Co., Minneapolis; Gordon W. Johnson, American Hoist & Derrick Co., St. Paul; and Carl Sweet, Minneapolis-Moline Power Implement Co., Minneapolis.

In addition, M. R. Berke, McKay Smelters, Ltd., Ottawa, Canada, has accepted membership. The committee would welcome to membership

any member interested in the work which the committee will do.

It is understood that the work of the committee outside the chapter area will, in general, be carried on by correspondence. These members from the Twin City chapter area expect to meet regularly to discuss their problems and correspondence sent in by interested members of the Association.

Objectives of the Committee are: (1) Review literature on analytical chemistry and report new methods of analysis applicable to the foundry industry; (2) Report shortcuts and simplifications of analytical methods developed and used in foundry laboratories; (3) Conduct experimental and research work in analytical methods; (4) Encourage use of chemical analysis for foundry purposes, and (5) Review the application of basic chemical concepts to foundry analysis.

The committee is particularly interested in encouraging the establishment of laboratories in smaller foundries. It would appreciate hearing from analysts in foundry laboratories who have special problems, or who have developed interesting methods of analysis.

The committee will devote its activities primarily to those methods of analysis used in foundries. It is hoped that none of its activities will in any way conflict with those carried on by the American Chemical Society or similar chemical bodies.

Those interested in keeping in touch with the committee, or requesting membership, are asked to get in touch with H. F. Scobie, Department of Mechanical Engineering, University of Minneapolis, Minneapolis 14, Minnesota.

Pangborn Wins Fourth "E"

PANGBORN Corporation, Hagerstown, Md., recently was awarded its fourth Army-Navy "E" citation for meritorious and continued production achievement, thus adding a third white star to the company's original "E" flag. Announcement of the award, made on May 5, was received at the Maryland plant simultaneously with the news of Germany's unconditional surrender.

The company also flies the U. S. Treasury "T" flag and the National Safety Award emblem.

AMERICAN FOUNDRYMAN

Fig. 5—Macrostructures of cast bronzes. Etched with 50 per cent HNO_3 solution. (A) Gun metal cast at 1150°C . (B) Gun metal cast at 50°C . above liquidus. (C) Nickel-tin (3 per cent) bronze cast at 1150°C . (D) Nickel-tin (3 per cent) bronze cast at 50°C . above liquidus.



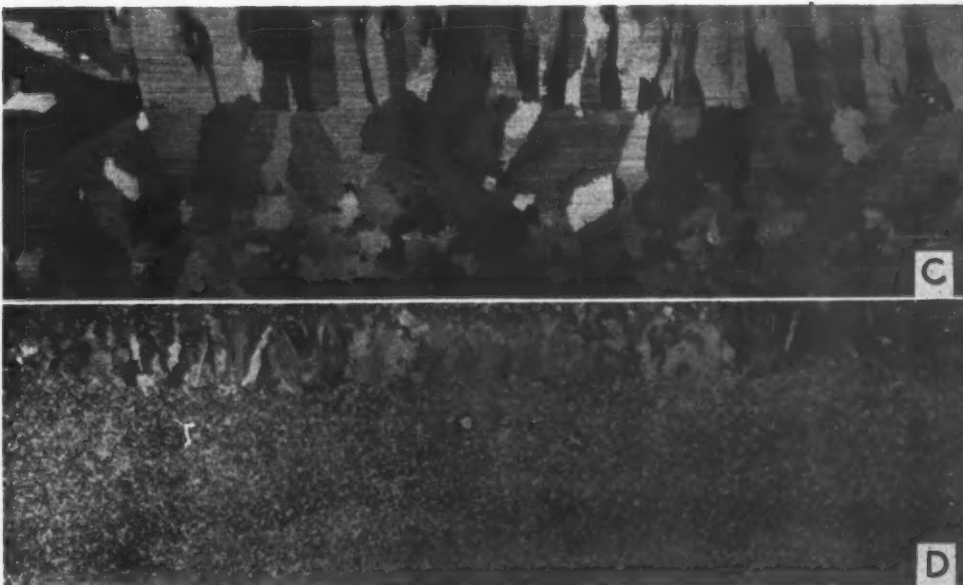
Distribution of Mechanical Properties in Sand Cast Bronzes

By R. H. Brouk, Ensign, U.S.N.R.,
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IT IS generally recognized that the mechanical properties of large castings are not necessarily equal to the mechanical properties of the separately cast coupon, and may vary from section to section in the same casting. This is especially true of castings of the tin bronzes which have pronounced coring and which also possess an inherent tendency for dispersed microshrinkage.

The composition of the bronze, foundry practice and the design of the casting appear to have important influences on the distribution of the microporosity, which in turn affects the mechanical properties. Little information is available regarding the correlation of these variables and the properties of tin-bronze castings.

The purpose of the present investigation was to study the effect of composition on the variations in mechanical properties in a heavy bronze casting. Five different bronzes were cast in heavy blocks and in separately cast coupons. The



blocks were then sectioned so that corresponding locations could be studied with respect to microstructure, grain size, specific gravity, chemical composition and mechanical properties.

Previous investigations have been limited to single compositions of bronze because of the great amount of time and labor involved. Rowe¹, in his investigation of an alloy of 90 per cent copper—10 per cent tin, has shown that the effects of microshrinkage on properties may be minimized by a high rate of solidification.

Rapid freezing gave finer grain size, greater hardness and higher density. Rowe favored high rates of solidification along with low casting temperatures.

Rahm², in his investigation of hydraulic bronze, reported that grain size had little effect on the mechanical properties and that the density was a more important factor. The investigation was made on castings $2\frac{3}{4}$ in. square and weighing 50 lb. each. The best properties occurred at the corners of the casting and were below the tensile properties of

• An investigation of variations in the mechanical properties of various bronze alloys as affected by chemical composition. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the Navy Department.

the test coupon as separately cast.

Pearson and Baker³ made a careful investigation of tin bronze (90:10) and phosphor bronze. The maximum density of the tin bronze was obtained by melting and casting in nitrogen and in a vacuum. Unsoundness was associated with the long freezing range of the bronze and was said to exist in the form of inter-dendritic fissures which increased in magnitude in sand cast (slowly cooled) bronzes. The variations in tensile properties in an ingot of tin bronze were related to concentrations of porosity.

Experimental Methods

(a) The Coupon and Casting

The separately cast coupon, shown in Fig. 1, is of the type required for gun metal, valve bronze and hydraulic bronze. It was gated at one end and two bars per mold were poured from a common runner.

The casting (Fig. 2) selected for the study of mechanical properties was a solid block, 8x6x3 in., horn gated as shown. The mold was tilted at an angle of 10 degrees during pouring, with the riser end lowest. The mold was then tilted in the opposite direction at an angle of 10 degrees to the horizontal during the period of solidification.

There was a tendency for microshrinkage at the center of the block for certain compositions of bronze, showing that the test was selective. The nominal compositions of bronze studied were as follows:

	Composition, per cent.				
	Cu	Sn	Zn	Pb	Ni
Gun Metal	88	9	3	....	....
Valve Bronze	89	6.5	3	1.5	....
Hydraulic Bronze	85	5	5	5	....
Nickel-Tin Bronze	88	6	3	....	3
Nickel-Tin Bronze	88	3	3	....	6

(b) Foundry Practice

The following metals were used in making the alloys: Grade A copper, electrolytic nickel, electrolytic slab zinc, Straits tin, and lead of high purity. The furnace charges con-



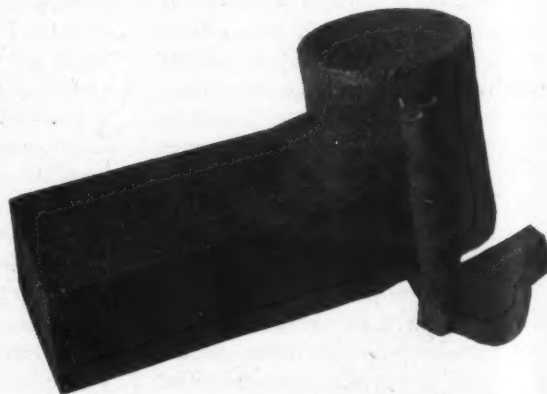
Fig. 1—Separately cast coupons of type required for gun metal, valve bronze and hydraulic bronze.

Table 1
CHEMICAL COMPOSITION AND MELTING PRACTICE—SAND CAST BRONZES

Heat No.	Location of Specimen	Composition, per cent					Pouring Temperature, °C.	Deoxidation Addition, P-Cu, oz.
		Cu	Sn	Zn*	Ni	Pb		
1G	Coupon	88.23	8.87	2.90			1150	1
2G	A	88.60	8.86	2.54			1100	2
	B	88.76	8.37	2.87				
	C	88.33	9.22	2.45				
3G	A	88.16	9.74	2.10			1050	3
	B	88.51	9.39	2.10				
	C	88.31	9.86	1.83				
4G	A	88.12	9.52	2.36			1150	3
	B	88.41	9.22	2.37				
	C	88.22	9.54	2.24				
5M	Coupon	87.61	7.09	3.82		1.48	1150	1
6M	A	87.56	7.04	3.80		1.60	1150	1½
	B	87.90	6.74	3.90		1.46		
	C	87.82	7.05	3.59		1.54		
7H	A	84.88	5.35	4.52		5.25	1150	1½
	B	84.96	5.27	4.52		5.25		
	C	84.96	5.28	4.58		5.18		
8G-3 Ni	Coupon	87.61	6.08	3.26	2.83	0.22	1120	2
9G-3 Ni	A	88.91	6.43	2.34	2.32		1100	5
	B	89.05	6.06	2.55	2.34			
	C	88.66	6.56	2.47	2.31			
10G-3 Ni	A	88.21	5.25	3.60	2.72	0.22	1150	5
	B	88.28	5.10	3.69	2.73	0.20		
	C	88.24	5.27	3.54	2.73	0.22		
11G-6 Ni	A	89.06	3.26	2.54	5.14		1150	5
		89.05	3.12	2.65	5.18			

*Zinc by difference.

Fig. 2—Solid block casting, 8x6x3 in., horn gated, for study of mechanical properties of various bronzes.



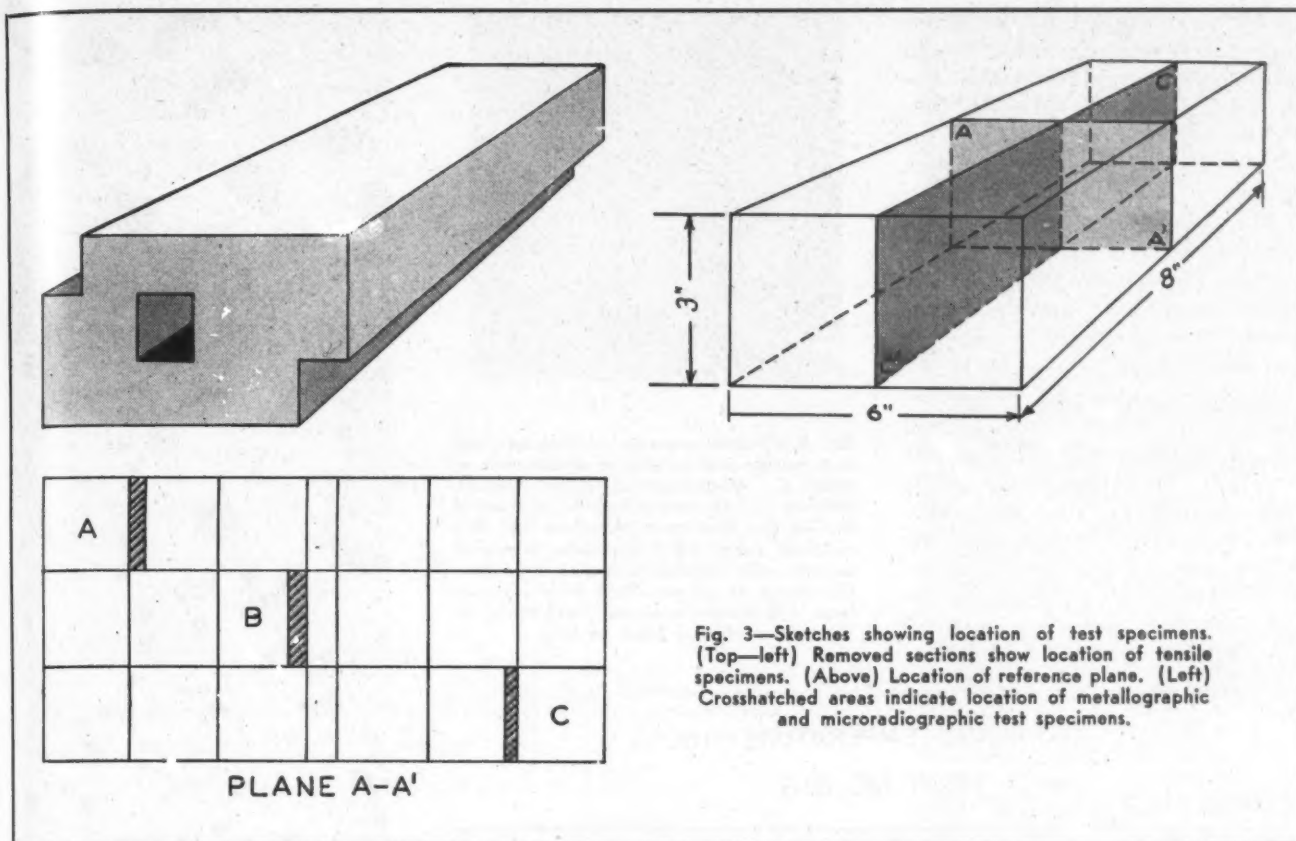


Fig. 3—Sketches showing location of test specimens. (Top—left) Removed sections show location of tensile specimens. (Above) Location of reference plane. (Left) Crosshatched areas indicate location of metallographic and microradiographic test specimens.

sisted of the virgin metals, copper-nickel master alloy and scrap of known composition from previous heats of virgin metal. A lift coil induction furnace with a clay-graphite crucible was used for melting.

The surface of the molten bronze was exposed to the atmosphere, but the melting was rapid in order to prevent excessive oxidation. At 1200° C. (2190° F.) an addition of phosphor-copper (10 per cent phosphorus) was made. Then the alloying elements were added to balance the composition, together with a second addition of phosphor copper (Table 1).

The bronzes were cast at 1150° C. (2100° F.), and several were cast at approximately 50° C. (90° F.) above the experimentally determined liquidus. The test coupon was cast first and the block immediately thereafter. The sprue was kept full so that the rate of metal flow into the mold cavity would be constant for each casting. The riser was covered with an anti-piping compound.

The molds were prepared from Albany green sand (Grade 1) with about 6 per cent moisture. The green compressive strength was 4 to

6 psi. and the A.F.A. permeability was 22. The molds were air dried for 24 hr. before casting.

(c) Investigation of the Block

Only radiographically sound blocks (penetrameter 1½ per cent) were sectioned for the mechanical tests. The material taken for the

tensile specimens, as shown in Fig. 3, also served for Brinell hardness and specific gravity measurements. Samples from adjacent positions were used for the grain size study, chemical analysis, hardness survey and metallography.

An attempt was made to take all of the measurements as closely as

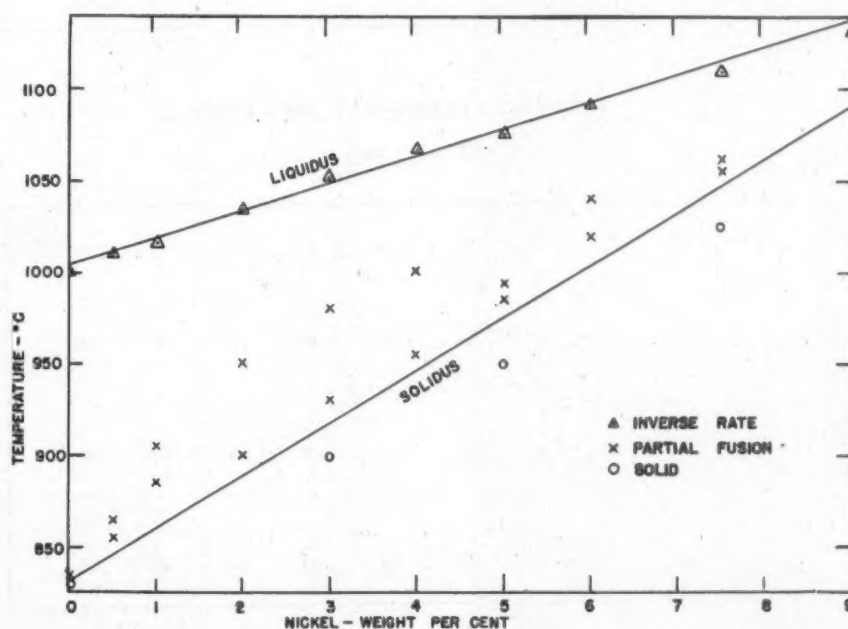


Fig. 4—Liquidus and solidus of Cu-Ni-Sn-Zn alloys of 88 per cent Cu, 3 per cent Zn, 9 per cent (Ni + Sn).

possible to the gauge lengths of the respective tensile test specimens in order to insure good correlation. The Brinell hardness was taken on cross sections of the threaded ends of the machined tensile test specimens themselves.

The samples for chemical analysis came from the 1/16 in. thick layer machined from around the periphery of the gauge length, and the specific gravity was determined from the machined tensile test specimens.

The specimens for microscopic examination were taken from a point not more than 3/16 in. from the center of the gauge length of the tensile test bars. After the photomicrographs had been taken, the etching on the specimens was removed by light polishing and the polished surface was then mounted

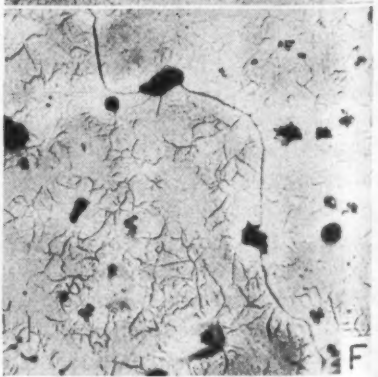
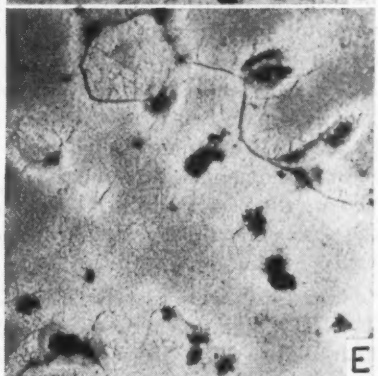
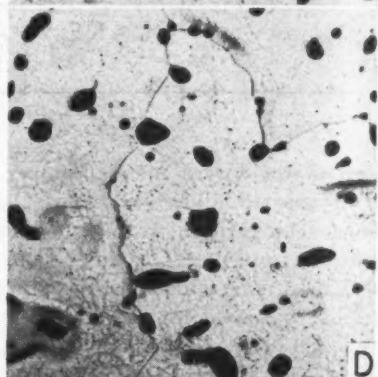
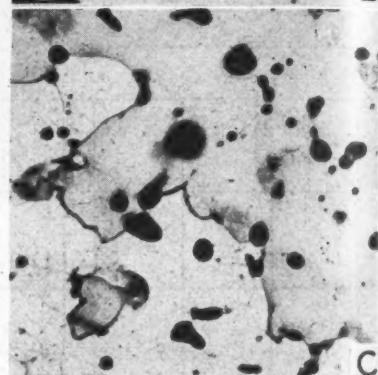
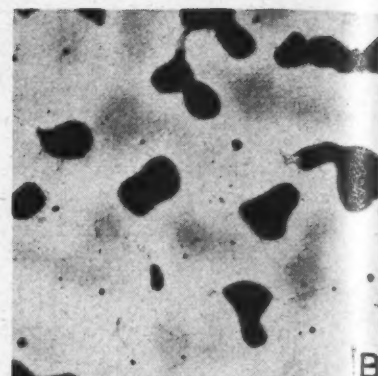
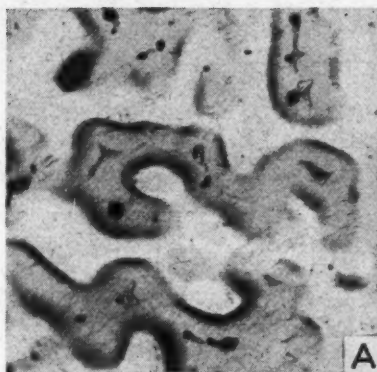


Fig. 7—Photomicrographs of test bars cut from center and surface of blocks cast at 1150° C. Magnification, $\times 75$. Etchant, $\text{NH}_4\text{OH} + \text{H}_2\text{O}_2$ and alcoholic solution of FeCl_3 . (A) Gun metal at surface (B) Gun metal at center. (C) Hydraulic bronze at surface. (D) Hydraulic bronze at center. (E) Nickel-tin (3 per cent) bronze at surface. (F) Nickel-tin (3 per cent) bronze at center of block casting.

POURING TEMPERATURE = 1150°C.

HEAT NO. 10G

COPE

	69	69	67	74	69	69	72	74	77	74
RISER END	69	67	67	74	69	69	69	74	72	77
	69	72	69	72	69	74	74	74	74	74
	72	69	72	72	74	69	69	74	77	80

DRAG

POURING TEMPERATURE = 1100°C.

HEAT NO. 9G

COPE

	67	65	65	67	65	65	65	67	65	65
RISER END	63	67	67	67	65	65	65	65	65	65
	63	63	63	61	61	61	65	65	67	65
	63	63	63	63	63	61	63	63	63	63

DRAG

Fig. 6—Hardness survey of cast block. Nominal composition, 88 per cent Cu, 3 per cent Zn, 6 per cent Sn, 3 per cent Ni.

face down on a steel holding plate.

The back of the specimen was then removed by milling and grinding until a thin slice 0.0025 in. thick remained. The thin slice was micro-radiographed with iron radiation and fine-grained spectroscopic film. By this means, the photomicrographs and microradiographs utilized were made of the identical bronze structures.

(d) Liquidus-Solidus Measurements

Since it had been reported that the long freezing range of tin bronzes is a cause of their unsoundness, the freezing ranges of various bronzes in which nickel was substituted for tin were determined. The nickel and tin totaled 9 per cent in this series. Two-lb. heats were cooled in graphite crucibles from a tempera-

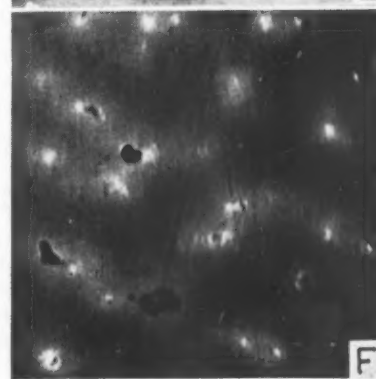
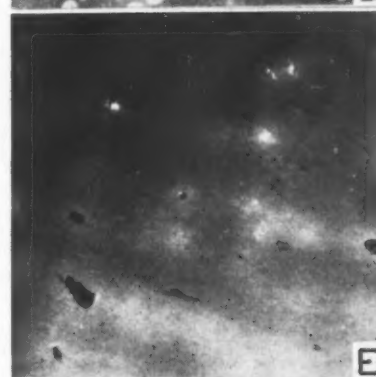
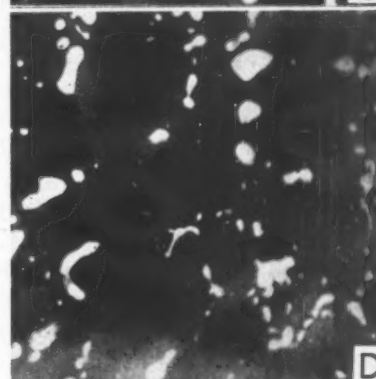
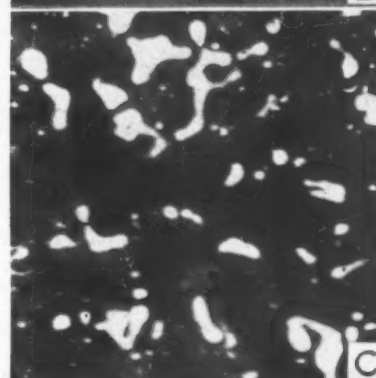
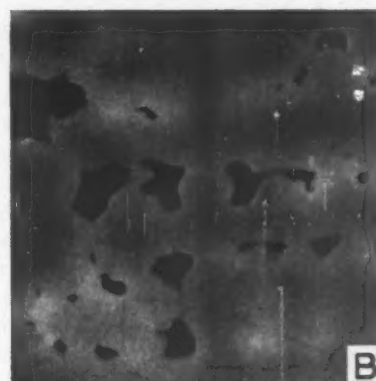
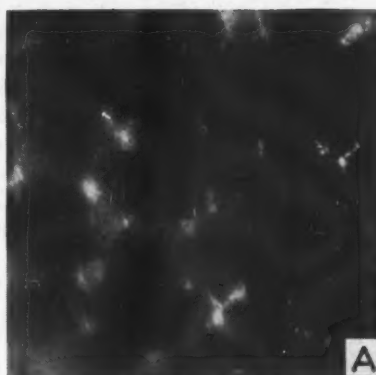


Fig. 8—Microradiographs of test bars cut from center and surface of blocks cast at 1150° C. Magnification, $\times 75$. Iron radiation—35 kv. (A) Gun metal at surface. (B) Gun metal at center. (C) Hydraulic bronze at surface. (D) Hydraulic bronze at center. (E) Nickel-tin (3 per cent) bronze at surface. (F) Nickel-tin (3 per cent) bronze at center of block.

Table 2
PROPERTIES OF SAND CAST BRONZE TEST BARS

Heat No.	Location of Test Bar	Pouring Temperature, °C.	Mechanical Properties				Specific Gravity at 20 °C.
			Tensile Strength, psi.	Elongation, per cent in 2 in.	BHN 500 kg. load 10 mm. ball 30 sec.		
1G	Coupon	1150	41,800	25.5	69		8.578
	A		42,400	55.0	78		8.679
	B		30,800	24.0	57		8.410
	C		43,900	40.0	69		8.664
2G	Coupon	1100	42,000	23.0	72		8.726
	A		45,200	60.0	74		8.789
	B		32,300	26.0	65		8.558
	C		44,100	35.0	72		8.736
3G	Coupon	1050	49,700	33.0	72		8.842
	A		41,700	23.0	77		8.787
	B		40,150	24.0	74		8.814
	C		53,700	68.0	74		8.824
4G	Coupon	1150	49,700	46.0	74		8.771
	A		49,700	63.0	74		8.691
	B		38,800	52.0	69		8.507
	C		45,800	54.5	63		8.706
5M	Coupon	1150	39,900	38.0	63		8.547
	A		38,800	36.0	63		8.613
	B		28,100	35.5	50		8.377
	C		39,100	50.0	80		8.710
6M	Coupon	1150	42,400	36.0	65		8.752
	A		39,800	66.5	61		8.796
	B		31,700	28.0	57		8.687
	C		41,300	45.5	59		8.804
7H	Coupon	1150	38,700	36.5	58		8.861
	A		35,700	36.5	57		8.855
	B		27,100	25.0	52		8.780
	C		31,100	26.0	56		8.852
8G-3 Ni	Coupon	1120	46,000	38.0	68		8.845
	A		43,400	50.0	65		8.851
	B		40,000	34.0	65		8.841
	C		48,400	43.5	69		8.883
9G-3 Ni	Coupon	1100	42,900	27.5	74		8.832
	A		49,900	29.5	72		8.883
	B		48,800	25.0	69		8.828
	C		49,050	57.5	77		8.878
10G-3 Ni	Coupon	1150	47,700	50.0	69		8.787
	A		43,400	50.0	69		8.718
	B		41,300	46.0	63		8.742
	C		43,800	47.5	69		8.750
11G-6 Ni	Coupon	1150	42,800	34.0	69		8.821
	A		43,750	38.0	72		8.807
	B		39,900	36.0	69		8.806
	C		41,600	38.0	72		8.822

ture 50° C. above the liquidus at a rate of 2° C. per minute.

The cooling curve for the liquidus temperature was determined to within 1° C. by the inverse rate method. However, the cooling curve for the solidus showed no clearly defined thermal arrest by this method. The solidus temperature was determined by microscopic examination for incipient melting in samples that had been cold worked and held for 2½ hr. at various temperatures before quenching in cold water (Fig. 4).

Some representative data showing the effect of pouring temperature on

This paper was secured as part of the 1945 "Year-Round Foundry Congress" and is sponsored by the Brass and Bronze Division of A.F.A.

the grain size and the distribution of hardness in gun metal and nickel-tin bronze are shown in Figs. 5 and 6. Low pouring temperature is responsible for fine grain size and more uniform hardness throughout the block.

Discussion of Data

In Fig 5, the centerline at the junction of large grains disappears at low pouring temperature. In Fig. 6, the hardness is shown to vary not more than 6 Brinell numbers when the nickel-tin bronze is poured at a temperature of approximately 50° C. above the liquidus.

The influence of composition on the distribution of porosity is illustrated in Figs. 7 and 8. The photomicrographs were taken at positions A and B (Fig. 3) of each block. The microradiographs in Fig. 8 and the photomicrographs in Fig 7 were made of the same samples.

Porosity in both figures appears as black angular shapes. The microporosity which is evident in all three

bronze compositions occurs adjacent to the low melting constituents in the interstices of the dendrites and grain boundaries. The microradiographs show further that lead in hydraulic bronze tends to fill these cavities. This is perhaps the reason for the high density of the hydraulic bronze at the center of the block.

Lead Distribution

The distribution of the lead which occurs as a network between dendrites in this location causes nearly as much loss in mechanical strength, however, as do the voids in the center of the heavy section of the gun metal. The nickel-tin bronze has the most uniform distribution of microporosity with no tendency for the intercommunicating type shown by gun metal and hydraulic bronze. The narrow solidification range of the nickel-tin bronze is a beneficial factor.

The differences in mechanical properties between the separately cast coupon and the casting largely depend on the composition and pouring temperature of the bronze. Gun metal, valve bronze, and hydraulic bronze, cast at 1150° C. (2100° F.) had a greater variation in mechanical properties than the nickel-tin bronzes with 3 to 6 per cent of nickel.

Lower casting temperature improved the soundness of gun metal and the nickel-tin bronzes, but the effect of differences in composition was still apparent. The tensile strength and elongation of selected heats (Table 2) cast at 1150° C. (2100° F.) may be summarized as shown in Table 3.

The nickel-tin bronze containing 3 and 6 per cent nickel has less variation in properties between the separately cast test coupon and casting and in different parts of the same casting. In casting heavy sections of this bronze, good foundry practice as well as proper deoxidation

methods are important if adequate mechanical properties are to be obtained.

The pouring temperature should be low without causing cold shuts or low fluidity. A special attempt should be made to secure directional solidification in the heavy section and feed the section with adequate risers.

Acknowledgments

The authors wish to acknowledge the assistance of the Metallography Group and Radiographic Sections of the Division of Physical Metallurgy of the Naval Research Laboratory.

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Douglas C. Williams, A.F.A. Sand Research Fellow, Cornell University, Ithaca, N. Y., recently gave a series of lectures on sand and sand testing to classes of engineering students at the University. The accompanying photograph shows Mr. Williams pointing out to the students the necessary procedures in the preparation of foundry sand for proper use in the casting of metals. Following the lecture series, students voted on what lectures were, in their estimation, most interesting. A major percentage of the students named Mr. Williams' lectures.



Table 3

TENSILE STRENGTH AND ELONGATION—SAND CAST BRONZES

Alloy	Heat No.	Separately Cast Bar		Center of Block		Top Corner of Block	
		Tensile Strength, psi.	Elongation, per cent in 2 in.	Tensile Strength, psi.	Elongation, per cent in 2 in.	Tensile Strength, psi.	Elongation, per cent in 2 in.
Composition G	1G	41,800	25.5	30,800	24.0	42,400	55.0
Composition M	6M	42,400	36.0	31,700	28.0	39,800	66.5
Red Brass	7H	38,700	36.5	27,100	25.0	35,700	36.5
Ni-Sn Bronze	10G	47,700	50.0	41,300	46.0	43,400	50.0
Ni-Sn Bronze	11G	42,800	34.0	39,900	36.0	43,750	38.0

STANDARD POURING PRACTICES for Magnesium and Aluminum Alloys

By A. McIntosh, Asst. Supt. of Foundries, Wright Aeronautical Corp.,
Paterson, N. J.

BEFORE pouring assume a steady position. Distribute the weight equally with the feet in a well balanced position. The lip of the ladle should be as near as possible to the sprue cup or runner basin.

Holding the ladle shank firmly in both hands, tilt the ladle and fill the runner basin or sprue cup with the least possible delay. Maintaining a steady pour, keep the basin, or sprue cup, filled at all times until the mold is poured.

If a runner basin is used the metal should be poured into the basin at the end furthest from the sprue. Metal that is poured directly from a sprue causes agitation and any foreign matter such as slag or loose sand will be forced down with the stream of metal. If the metal is poured away from the sprue, a pool of metal is soon set up in the basin which allows slag, dross and other materials to float on the surface and only clean metal from the bottom of the pool finds its way down the sprue.

Care should be taken while pouring so as not to spill metal over the sides of the sprue or basin nor to splash metal down the risers. Metal spilled down a riser, when the mold is not yet filled, may carry loose sand into the mold, causing a hole.

Cause of Cold Shuts

Spilled metal also may lodge on a core and set up a chill effect, causing a cold shut. If the metal is hot enough to run through the mold to join with the parent metal it will tend to set up streaks in the mold walls. Leakage of metal down the riser of a magnesium mold sets up brownish streaks resulting from burning out the inhibitor. This will often result in a leaky casting when the water test is applied.

Men pouring metal should always wear goggles and protective clothing. The use of goggles should be compulsory while pouring. Numerous causes can result in a blow, while working with magnesium, and eye injuries could be reduced to a minimum. Safety shoes and protective leggings also should be worn,

because as long as we have foundries we will have run-outs. It is better to lose a casting than to lose an operator to the hospital. Many a valuable casting could be saved by the assurance protective clothing affords.

H. F. Taylor Becomes Head of Sand Subcommittee

FOLLOWING the request of Werner Finster, Reading Steel Casting Div., American Chain & Cable Co., Reading, Pa., that he be relieved of the chairmanship of the Subcommittee on Physical Properties of Steel Foundry Sands at Elevated Temperatures, Foundry Sand Research Project, after two years of service, Howard F. Taylor, Naval Research Laboratory, Anacostia Station, Washington, D. C., formerly vice chairman of the subcommittee, has been appointed chairman. John A. Rassenfoss, American Steel

Foundries, East Chicago, Ind., has been named vice chairman.

During Mr. Finster's term as chairman, great progress has been made in the activities supervised by the subcommittee. Under his direction, new enthusiasm and life have been added to the work of the subcommittee, and it is with regret that your Association has accepted his resignation as chairman. It is pleased, however, that he will remain an active member of the group.

Other members of the subcommittee are: D. C. Williams, Cornell University, Ithaca, N. Y., *secretary*; C. W. Briggs, Steel Founders' Society of America, Cleveland, O.; H. W. Dietert, Harry W. Dietert Co., Detroit, Mich.; R. A. Gezelius, General Steel Castings Corp., Eddystone, Pa.; John Howe Hall, Swarthmore, Pa.; J. W. Juppenlatz, Lebanon Steel Foundry, Lebanon, Pa.; H. M. Kraner, Bethlehem Steel Co., Bethlehem, Pa.; J. R. Moynihan, Cornell University, Ithaca, N. Y.; Emile Pragoff, Jr., Hercules Powder Co., Wilmington, Del.; W. G. Reichert, W. G. Reichert Engineering Co., Newark, N. J.; F. B. Riggan, Key Co., East St. Louis, Ill., and E. E. Woodliff, Foundry Sand Service Engineering Co., Detroit.

A.F.A. MEMBERSHIP DUES

(Effective July 1, 1945)

<i>Present Dues</i>	<i>Class of Membership</i>	<i>Annual Dues July 1, 1945</i>
\$50.00 minimum	SUSTAINING	minimum \$100.00
For firms desiring to aid the Association's aims and purposes in more direct proportion to the benefits they may have received.		
\$25.00 annual	COMPANY	annual \$50.00
Separate Company membership is required for each plant of any one organization. An individual connected with a plant holding Sustaining or Company membership may become a Personal member with dues of only \$8.00 per year.		
\$15.00 annual	PERSONAL	annual \$15.00
For individuals whose plants or organizations do not hold Sustaining or Company membership.		
\$8.00 annual	PERSONAL (AFFILIATE)	annual \$8.00
Only for individuals connected with plants holding Sustaining or Company memberships.		
\$8.00 annual	PERSONAL (ASSOCIATE)	annual \$8.00
Only for individuals engaged solely in educational, Government or military work.		
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Application for Student or Apprentice membership should be signed or verified by the Instructor or Supervisor.		

(Membership in the National Association includes membership in any A.F.A. Chapter desired, without payment of additional dues or fees.)

NEW ASSOCIATION MEMBERS

(April 16 to May 15, 1945)



*** This list of 108 new Association members and two conversions from Personal to Company memberships, is ample evidence that the membership committees kept up their vigilance even though many chapters have concluded their year's work. Twenty-one chapters are represented on these pages with Chicago contributing 15 new names and Michiana and Northeastern Ohio adding 9 new men to their chapters' membership roles.**

Conversions—Personal to Company

- *Production Foundry Co., Oakland, Calif. (Leon Cameto, Owner) (No. California Chapter).
- *Stoller Chemical Co., Akron, Ohio (Robert A. Epps, Consultant) (Canton District Chapter).

BIRMINGHAM CHAPTER

W. W. McCulloch, Research, American Cast Iron Pipe Co., Birmingham.

CANTON DISTRICT CHAPTER

Millard B. Hoffman, Engineer, Norris & Elliott, Inc., Columbus, Ohio.

CENTRAL NEW YORK CHAPTER

- *Frank L. Phillips Co., Binghamton, N. Y. (Mrs. Frank L. Phillips, Owner).

CENTRAL OHIO CHAPTER

- Leroy Fink, Battelle Memorial Institute, Columbus, Ohio.
- W. H. Griffith, International Derrick & Equipment Co., Columbus, Ohio.
- *International Derrick & Equipment Co., Columbus, Ohio.

CHESAPEAKE CHAPTER

- L. M. Dellinger, Chief Mech. Engr., Westinghouse Electric Corp., Baltimore.
- Russell Gilman Hardy, C Sp., U.S.N.R., U. S. Naval Research Laboratory, Washington, D. C.
- Lt. (j.g.) John T. Robertson, U.S.N.R., Met., U. S. Naval Research Laboratory, Washington, D. C.
- Wm. H. Thumel, American Hammered Piston Ring Co., Baltimore.

CHICAGO CHAPTER

- Pol G. Boel, Special Engr., American Steel Foundries, East Chicago, Ind.
- Robert H. Burnell, Ass't. Branch Mgr., The Federal Foundry Supply Co., Chicago.
- S. L. Feduska, Indiana Steel Products Co., Valparaiso, Ind.
- Charles W. Gay, Sup't., Production, American Steel Foundries, E. Chicago, Ind.
- James R. Goldsmith, Met. Engr., Crane Co., Chicago.
- William H. Hentig, Sivyer Steel Castings Co., Chicago.
- Martin H. Kalina, Supv., Ferrous Metallurgy, Armour Research Foundation, Chicago.
- Lester B. Knight, Consulting Engineer, Northbrook, Ill.
- Frank B. Kozlik, Works Mgr., Central Pattern & Foundry Co., Chicago.
- James Morrison, Ass't. Works Mgr., American Steel Foundries, Chicago.
- W. C. Perz, Chicago.
- C. C. Robertson, Sup't. of Patterns, American Steel Foundries, E. Chicago, Ind.
- John E. Schenk, Supv., Pettibone-Mulliken Corp., Chicago.
- E. H. Schleede, Dev. Engr., U. S. Gypsum Co., Chicago.
- Louis W. Soldan, Ass't. Gen. Sup't. of Foundries, Crane Co., Chicago.

CINCINNATI DISTRICT CHAPTER

- Joseph J. Farkas, Ass't. Fdry. Prod. Mgr., Cincinnati Milling Machine Co., Cincinnati.

DETROIT CHAPTER

- Lincoln E. Crone, Engr., United Bronze Corp., Detroit.
- *Horne Bronze Foundry Co., Detroit (E. B. Horne, Gen. Mgr.)
- William King, Charge of Pattern Equip., Ford Motor Co., Windsor, Ont., Canada.
- H. R. Padelford, Chemist, Chrysler Corp., Dodge Main Foundry, Hamtramck, Mich.
- William N. Seese, Service Engr., J. S. McCormick Co., Detroit.
- Wayne University Library, Detroit.
- Roy Wormley, Ass't. Sup't., U. S. Radiator Corp., Detroit.

EASTERN CANADA & NEWFOUNDLAND CHAPTER

- *Bruce Stewart & Co., Ltd., Charlottetown, P.E.I., Canada (C. L. Mackay, Gen. Mgr.).
- A. A. Fleming, Chief Chemist & Met., Dominion Arsenal, Quebec, P.Q., Canada.
- Major General G. B. Howard, Controller-General, Inspection Board of U.K. & Canada, Ottawa, Ont., Canada.
- C. J. Lynde, Acting Mgr., C. O. Clark & Bro., Ltd., Montreal, Quebec.
- *Morash Foundry, Morrisburg, Ontario (Dick Morash, Repr.).
- A. E. Jurton, Wartime Technologist, Dep't. of Mines and Resources, Ottawa, Ont., Canada.

*Company Member.

METROPOLITAN CHAPTER

- J. Fred. Bauer, Salesman, Hickman, Williams & Co., New York City.
- James W. Chamberlain, Sup't. Core Room, Cooper Alloy Foundry Co., Hillside, N. J.
- Joseph W. Panuska, Mgr., The Central Foundry Co., Essex Div., Newark, N. J.

MICHIANA CHAPTER

- Percy Beidler, Gen. Foreman, Round Oak Co., Dowagiac, Mich.
- Albert A. Blaskie, American Foundry Equipment Co., Mishawaka, Ind.
- H. Borchelt, Cost Accountant, Kunkle Valve Co., Fort Wayne, Ind.
- Forest D. Dull, Elkhart Foundry & Machine Co., Elkhart, Ind.
- Will Graber, Molding Foreman, Round Oak Co., Dowagiac, Mich.
- Virgil Huff, American Foundry Equipment Co., Mishawaka, Ind.
- Stanley F. Krzeazowski, Special Ass't. to Vice-Pres., American Foundry Equipment Co., Mishawaka, Ind.
- *Kunkle Valve Co., Fort Wayne, Ind. (A. J. Bahr, Foundry Sup't.).
- John J. Stobie, Jr., Chief Met., Round Oak Co., Dowagiac, Mich.

NORTHEASTERN OHIO CHAPTER

- Walter A. Atkins, Foreman, The Standard Stoker Co., Inc., Erie, Penna.
- Alexander S. Downie, Foundry Foreman, The Standard Stoker Co., Erie, Penna.
- David A. Fourspring, Ass't. Sup't., The Standard Stoker Co., Erie, Penna.
- John W. Gresham, Foundry Practice Tech., National Bronze & Aluminum Foundry Co., Cleveland.
- John E. Kocsis, Foundry Foreman, National Bronze & Aluminum Foundry Co., Cleveland.
- James W. Moss, Melter Foreman, The Standard Stoker Co., Erie, Penna.
- Oliver G. Shadle, Sr., Foreman of Iron Foundry, The Standard Stoker Co., Erie, Penna.
- Loyal G. Tinkler, Metallurgical Engr., Vanadium Corp. of America, Cleveland.
- Earl J. Volk, Pattern Shop Foreman, The Standard Stoker Co., Erie, Penna.

NORTHERN CALIFORNIA CHAPTER

- Harry Barnett, General Eng. & D. D. Co., San Francisco.
- *Food Machinery Corp., San Jose, Calif. (Willis Noethig, Foundry Foreman).
- John Kelly Giffen, Production Control, General Metals Corp., Oakland.
- Joseph Gomes, Foreman, Production Foundry Co., Oakland.

OREGON CHAPTER

- Ray Arnold, Ass't. Sup't., Columbia Steel Casting Co., Portland.
- Don S. Burnett, Chief Engr., Pacific Steel Foundry, Portland.
- Andrew J. Grbavac, Foundry Sup't., Columbia Steel Casting Co., Portland.
- O. W. Kramer, Met., Columbia Steel Casting Co., Portland.
- Floyd O. Smith, Engineer, Columbia Steel Casting Co., Portland.
- Frank E. Smith, Tray Lead Core Maker, Pacific Steel Foundry, Portland.

PHILADELPHIA CHAPTER

- Edward P. Kinney, Finishing Foreman, Swedish Crucible Steel Co., Detroit, Mich.
- William A. Rennie, Foundry Supv., General Steel Castings Corp., Eddystone, Penna.
- Manuel Tama, Vice-Pres., Ajax Engineering Corp., Trenton, N. J.

QUAD-CITY CHAPTER

- William H. Hamelau, Foundry Sup't., Gra-Iron Foundry Corp., Marshalltown, Iowa.
- Wesley S. Roper, Plant Engineering Dep't., J. I. Case Co., Rock Island, Illinois.
- Herman H. Tietjen, Owner, Progressive Foundry Co., Perry, Iowa.

SOUTHERN CALIFORNIA CHAPTER

- Ralph R. Ellis, Product Engr., Aluminum Co. of America, Vernon, Calif.
- Robert P. Franck, Met., Aluminum Co. of America, Vernon, Calif.
- *G-B Brass & Aluminum Foundry Inc., Los Angeles (A. L. Goodreau, Vice-Pres. & Gen. Mgr.).
- Gordon E. Miner, Foundry Methods Supv., Aluminum Co. of America, Vernon, Calif.
- *Taft Alloy Steel Co., Taft, Calif. (M. S. White, Managing Dir.).

TEXAS CHAPTER

- Lloyd G. Berryman, Chief Met., Lufkin Foundry & Machine Co., Lufkin, Texas.
- *Cockrell Supply Co., Houston, Texas (Thomas A. Cockrell, Owner).
- *Cla. Constructora De Maquinaria, S.A., Mexico, D.F., Mexico (Ernesto Villalobos, Gen. Mgr.).

AMERICAN FOUNDRYMAN

Lloyd Metal Foundry Co., Houston, Texas (John B. Lloyd, Mgr.)
N. L. Lloyd, Ass't. Mgr., Lloyd Metal Foundry Co., Houston, Texas.
A. Zapata, Manager, Fierro Esmaltado, S. de R.L., Tacubaya, D. F., Mexico.

TWIN-CITY CHAPTER

Earl S. Hinners, Dist. Sales Mgr., A. P. Green Fire Brick Co., Minneapolis.
William J. Hugo, Sales & Service Engr., Kuhlman Electric Co., Minneapolis.

WESTERN MICHIGAN CHAPTER

Harry J. Berkel, Core Room Sup't., Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.
Robert L. Lee, Process Engr., Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.
Schulze O. Nafe, Standards Engr., Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.
John E. Sargeant, Standards Engr., Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.
Stanley J. Thompson, Service Engr., Ingersoll Rand Co., Detroit.

WISCONSIN CHAPTER

E. E. Jagmin, Gen. Sup't., Ampco Metal, Inc., Milwaukee.

*Company Member.

Steven Lukacek, Wehr Steel Co., Milwaukee.

*Wisconsin Metal Fabricating Co., Milwaukee (Lester J. Marks, Pres.).

OUTSIDE OF CHAPTER

C. Mark Baatz, Chief Chemist, United Engineering & Foundry Co., New Castle, Penna.
John E. Biggerstaff, Ass't. Foreman, American Locomotive Co., Schenectady, N. Y.
Walter Brindley, Foundry Mgr., The Daimler Co., Ltd., Coventry, Eng.
*The Clyde Engineering Co., Ltd., Granville, N.S.W., Australia (J. T. Fischer, Gen. Mgr.).
Lloyd B. Cogswell, Vice-Pres., Cogswell Foundry & Machine Co., High Gate Center, Vt.
*Queensland Electric Steel, Ltd., Brisbane, Queensland, Australia (Robert Knox Dobbie).
Silvio S. Grasso, Ass't. Foreman, American Locomotive Co., Schenectady, N. Y.
Robert H. Hoyt, Foundry Engr., Ross-Meehan Foundries, Chattanooga, Tennessee.
Andrew J. McCloskey, Ass't. Foreman, American Locomotive Co., Schenectady, N. Y.
Officer-in-Charge, National Standards Laboratory, Chippendale, N.S.W., Australia.
*Westinghouse Brake Pty. Ltd., Sydney, Australia (J. White, Mgr. & Chief Engr.).

... of Interest to Foundrymen

Henning A. Forsberg was recently appointed manager of operations, Continental Foundry & Machine Co., East Chicago, Ind. Since 1931 Mr. Forsberg had served as general superintendent for all four works. The manager is an active member of the A.F.A. Chicago chapter.



G. P. Vincent



R. E. Gage

G. P. Vincent, manager, sales development and technical service department, The Mathieson Alkali Works, New York, N. Y., has been appointed technical director. R. E. Gage, who was director of research and development, has been named technical advisor.

Charles A. H. Knapp, formerly chief metallurgist for Jenkins Bros., Inc., Bridgeport, Conn., has joined the technical staff of R. Lavin & Sons, Inc., Chicago, as metallurgical and research engineer. Mr. Knapp's experience covers more than twenty years of work in chemistry, metallurgy and foundry practice.

Dr. Maxwell Gensamer, formerly of Carnegie Institute of Technology, has been named professor of metallurgy and head of mineral

technology, Pennsylvania State College, State College, Pa.

Dr. Robert C. McMaster, formerly associated with the electrical engineering staff at the California Institute of Technology, has been appointed to the staff of Battelle Memorial Institute, Columbus, O., and assigned to its division of industrial physics.

Warner Arms Wick, formerly assistant to vice president, has been named assistant manager in charge of production, The Falcon Bronze Co., Youngstown, O. T. C. Watts, who was director and former superintendent, is manager in charge of personnel and supplies. J. C. Lopatta has become foundry superintendent.



W. A. Wick



T. C. Watts

Edwin A. Walcher, vice-president, Ohio Steel Foundry Co., Lima and Springfield, Ohio, at a meeting of Steel Founders' Society of America in Chicago, May 18, received the society's new technical and operating medal for 1944. Mr. Walcher was honored for his firm's development of cast steel breech rings for field, naval and aircraft

ordnance. At the same meeting, Claude L. Harrell, vice-president, Sterling Steel Casting Co., East St. Louis, Ill., received the Frederick A. Lorenz Memorial Medal for his services as chairman of the Steel Castings Industry Advisory Committee to OPA.

Oliver E. Mount, vice-president, American Steel Foundries, Chicago, was presented with a handsome scroll embodying resolutions in appreciation of his three years as president of the Society.



J. C. Lopatta



G. B. Michie

George B. Michie, formerly in charge of purchasing and priorities, has been elected vice president in charge of sales, Electro Refractories & Alloys Corp., Buffalo, N. Y. Mr. Michie is a member of the A.F.A. Western New York chapter and served as a committee chairman during the 48th Annual A.F.A. Convention in Buffalo in 1944.

M. D. Johnson, for several years formerly Chief Inspector of the Caterpillar Tractor Co., Peoria, Ill., and first chairman of the A.F.A. Committee on Inspection of Castings, has become connected with Graham-Paige Motors Corp., Detroit, on the staff of the Director of Manufacturing, and has moved to Detroit.

CHAPTER ACTIVITIES

News

See page 92 for list of Chapter representatives whose reports of local activities appear in this issue.

SAGINAW VALLEY GROUP Becomes Thirtieth A.F.A. Chapter

By J. J. Clark

DR. STORK dropped off a new "baby chapter" in the neighborhood of Saginaw Valley during May. The new "baby chapter" has been operating successfully for the past year as a branch of the Detroit chapter. However, longing to become a full-fledged member of the Association's family, the group peti-

speak on "Progress with Better Methods and Motion Study."

Foundry jobs involving repetitive motions on the part of the workman, such as production coremaking or molding, can be made much less fatiguing and far more productive if materials and equipment are arranged to allow the least fatiguing



Saginaw Valley Chapter coming in for a landing as Chapter No. 30, via Stork Express.

tioned the A.F.A. Board of Directors and received the official sanction to become a chapter, starting with their meetings in the fall. The Saginaw Valley chapter thus becomes the thirtieth chapter of the American Foundrymen's Association.

A record group of Saginaw Valley foundrymen gathered at Frankenthuth, Mich., May 3, to hear James H. Smith, general manager, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich.,

motions to be used, the speaker stated.

Stuart Martin, production manager, of the same company, helped Mr. Smith in an actual demonstration of coremaking illustrating how time and motion study is applied.

The results of the chapter election were given at this meeting. The following men were elected as officers and directors of the new chapter: *Chairman*, H. G. McMurtry, Buick Motor Div., Flint; *Vice-Chairman*, John Smith, Chevrolet

Grey Iron Foundry, Saginaw; *Secretary-Treasurer*, M. V. Chamberlain, Dow Chemical Co., Midland; *Directors*, E. H. Bankard, Buick Motor Div., Flint; J. E. Bowen, Chevrolet Grey Iron Foundry, Saginaw; K. H. Priestley, Eaton Mfg. Co., Vassar; and O. E. Sundstedt, General Foundry & Mfg. Co., Flint.

Group Discussions End Chicago Chapter Meetings

THE Chicago chapter had an excellent turnout for its last meeting of the year, which was held on the evening of May 7 at the Chicago Bar Association. The chapter meeting was in the form of a round table discussion and the members broke up into four sections.

The steel section, under the direction of A. W. Gregg, executive engineer, Equipment Div., Whiting Corp., Harvey, Ill., had for its speaker John S. Townsend, superintendent of maintenance, South Works, Carnegie-Illinois Steel Corp., Chicago, Ill. Mr. Townsend gave a very good talk on "Foundry Maintenance."

A joint session between the gray iron and patternmaking divisions heard S. E. Langenberg, engineer, Western Foundry Co., Chicago, Ill., discuss "Modern Molding Methods." E. E. Sabey, pattern shop foreman, Miehle Printing Press & Mfg. Co., Chicago, Ill., presided as chairman.

The malleable group had a very interesting session with Chairman Kenneth Smith, foundry foreman, National Malleable & Steel Castings Co., Cicero, Ill., presiding. The speaker, Russell J. Anderson, general superintendent, Belle City Malleable Iron Co., Racine, Wis., talked

AMERICAN FOUNDRYMAN

on "The Advantages of Mechanization in the Foundry."

The non-ferrous division was especially fortunate in having as their speaker, W. Laird, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., who discussed "Progressive Solidification in Brass and Bronze Castings." The chairman was H. E. Ferguson, plant superintendent, Acme Aluminum Foundry Co., Chicago, Ill.

Results of the annual election of

officers and directors were as follows: *Chairman*, J. C. Gore, The Werner G. Smith Co.; *Vice-Chairman*, F. E. Wartgow, Hasbrouck Haynes, Engineers; *Secretary*, L. C. Smith, Peninsular Grinding Wheel Co.; *Treasurer*, B. L. Simpson, National Engineering Co.; *Directors*, D. A. Farrell, Carnegie-Illinois Steel Corp.; A. S. Klopff, Firegan Sales Co.; C. G. Mate, Greenlee Foundry, and Dr. R. F. Thomson, Dodge Chicago plant.

ERIE CHAPTER ON WAY AS Group Petitions Board for Approval

ON the evening of May 21 some 350 Association members and guests met at the Moose Club, Erie, Pa., in response to a call by the local Erie A.F.A. Committee. A dinner, preceding the evening meeting, was well attended. Following the dinner, members and guests gathered in the ballroom for the meeting. The chairman was R. W. Griswold Jr., fdry. supt., Griswold Mfg. Co., Erie, Pa.

At this meeting R. E. Kennedy, Secretary, A.F.A., gave a talk on A.F.A. and chapter formation. Following Mr. Kennedy's talk, the principal speaker of the evening was James H. Smith, gen. mgr., Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich., who gave a demonstration and talk on "Progress in Foundries with Better Methods and Motion Study."

Mr. Smith, who earlier this year was nominated a National Director of A.F.A., was assisted by Mr. Stuart Martin, Production Mgr., of the Saginaw Malleable Iron Div.

Before the meeting was adjourned, a large number of members and guests signed a petition to the A.F.A. Board of Directors asking for approval of a chapter in the northeastern Pennsylvania area. Announcement was made that the election of officers would be held at the meeting in Erie on June 25, at which time chapter officials will be selected for the coming year.

The local committee sponsoring the meeting consisted of the following, in addition to Chairman Griswold: Kenneth Guyer, foundry supt., Bucyrus-Erie Co., Erie; Earl M. Strick, finishing supt., Erie Malleable Iron Co., Erie; William Mil-

ler, dist. sales mgr., F. B. Stevens, Inc., Erie; and Ralph T. Wedgewood, dist. sales mgr., Pickands Mather & Co., Erie.

Donoho Covers Centrifugal Casting at Philadelphia

By B. A. Miller

GIVING the "hows and whys" of centrifugal casting, C. K. Donoho, American Cast Iron Pipe Co., Birmingham, Ala., spoke on "Centrifugal Castings" at the May 11 Philadelphia chapter meeting. The slides used by the speaker were most interesting. They showed that in a number of cases centrifugal castings are far superior than even castings made from forgings, as far as destructive tests were concerned.

The election of officers was held at this meeting and the results were: *Chairman*, John M. Robb, Jr., Hickman, Williams & Co., Inc.; *Vice-Chairman*, B. A. Miller, The Baldwin Locomotive Works; *Secretary-Treasurer*, W. B. Coleman, W. B. Coleman & Co.; *Directors*, Earl Eastburn, Phosphor Bronze Smelting Co.; H. E. Mandel, Pennsylvania Foundry Supply & Sand Co.; J. W. March, Camden Foundry Co.; E. C. Troy, Dodge Steel Co.; C. L. Lane, Florence Pipe Foundry & Mach. Co.; and B. H. Bartells, University of Pennsylvania.

Metropolitan Chapter Elects 1945-46 Officers

By George Hadzima

AT the recent meeting of the Metropolitan chapter, officers and directors were elected for the forthcoming year. Those elected include: *Chairman*, H. A. Deane, American Brake Shoe Co., Newark, N. J.; *Vice-Chairman*, Harold L. Ullrich, Sacks Barlow Foundries, Inc., Newark, N. J.; *Secretary*, George Hadzima, Robins Conveyors, Inc., Passaic, N. J.; *Treasurer*, H. B. Caldwell, Whiting Corp., New York City; *Directors*, Alex McIntosh, Wright Aeronautical Corp., Paterson, N. J.; J. S. Vanick, International Nickel Co., New York City; C. J. Law, Worthington Pump & Mach. Co., Harrison, N. J.; A. B.



Eastern Canada and Newfoundland chapter apprentices shown with Henri Louette (seated front row, fifth from right), Warden King, Ltd., and Chairman, Educational Committee.

McCullough, American Steel Castings Co., Newark, N. J.; Wm. E. Paulson, Thos. Paulson & Son, Inc.; and D. S. Yeomans, Pettinos Bros., S. Orange, N. J.

Casting Defects Questions Answered by Committeemen

By H. L. Creps

HOW the Committee on Casting Defects has been reviewing the cause of scrap castings for the past five years was outlined by W. A. Hambley, works metallurgist, Allis-Chalmers Mfg. Co., committee chairman, and A. S. Klopff, manager, Firegan Sales Co., committee secretary, before the Quad City chapter April 16. This discussion of scrap castings was held in the form of a round table conference, with the two speakers showing many slides illustrating all types of defects common to the industry. The men stated that a total of 32 classifications have been made to cover the various types of scrap.

A moving picture, "Bottom Pour Ladle Practice," was shown by S. E. McGinty, sales manager, Firegan Sales Co., following dinner.

Rochester Hears Smith On Shop Modernization

By C. B. Johnson

AN interesting and enlightening address on "Mechanization and Modernization" was made by Norman L. Smith, Link-Belt Co., Philadelphia, Pa., to members and guests of the Rochester chapter, May 11.

Special attention was given to James E. McHenry, Gleason Works, Rochester, N. Y., who was duly honored by the chapter for having completed 50 years of foundry service. Jim was presented with a token of remembrance from the chapter and also the A.F.A. 50-year pin.

Officers elected for 1945-46 include: *President*, Walter F. Morton, The Anstice Co., Inc., *Vice-President*, Walter G. Brayer, Bausch & Lomb Optical Co., and *Secretary-Treasurer*, Carl B. Johnson, Symington-Gould Corp.

The following are the list of

new Chapter *Directors*: David D. Baxter, Sterling Wheelbarrow Co.; I. A. Billiar, Symington-Gould Corp.; Neal F. Clement, Rochester-Erie Foundry Corp.; M. T. Ganzauge, General Railway Signal Co.; L. C. Gleason, Gleason Works; Henry B. Hanley, American Laundry Machy. Co.; Herman G. Hetzler, Hetzler Foundries, Inc.; Irving B. Rosenthal, Rochester Smelting & Refining Co., and Ernest N. Van Billiard, Progressive Foundry Works.

Detroit Round Table Covers Many Practices

By H. H. Wilder

PRODUCTION roundtable conferences held on brass, malleable iron and cupola operation made up the Detroit chapter's May meeting held at Horace H. Rackham Educational Memorial, May 17.

E. D. Mooney, Federated Metals Div., American Smelting & Refining Co., Whiting, Ind., talked on silicon bronzes before the brass group. Casting practice and its relationship

to sand temperatures, cores and pouring were covered. J. P. Carritte, Jr., president, True Alloys, Inc., Detroit, acted as moderator.

"Control Methods in Malleable Foundries" was presented by Charles Morrison, Saginaw Malleable Iron Div., General Motors Corp., Saginaw, Mich. Methods for control of melting, gating, heat treatment and inspection were thoroughly covered by the speaker. The discussion leader was G. L. Galmish, Michigan Malleable Iron Co., Detroit.

Gordon C. Creusere, Semet-Solvay Co., Detroit, acted as leader for discussion on "Cupola Operations," with H. S. Austin, Buick Motor Co., Flint, as speaker. Mr. Austin started with bed preparation, lighting, charge makeup, melting rate, metal control and relining operations.

At this meeting E. C. Hoenicke, assistant to the general manager, foundry division, Eaton Mfg. Co., was elected chairman of the Detroit chapter. After serving five years as secretary, A. H. Allen, Detroit editor, Penton Publishing Co., was elected vice chairman. H. H. Wilder, Vanadium Corp. of America, is the new secretary and W. W.



(Photos courtesy A. B. Shuck, Koppers Co.)

Top—Fred Seifing addressing the Chesapeake chapter. Center—Seated at the speaker's table at the Chesapeake chapter are (left to right) W. R. Bean, Whiting Corp.; W. W. Rose, Gray Iron Founders' Society; Chapter chairman H. A. Horner, Frick Co., Inc.; Guest speaker F. G. Seifing, International Nickel Co.; Chapter director J. E. Crown, U. S. Naval Gun Factory; Chapter director E. W. Horlebein, The Gibson & Kirk Co.; and F. G. Steinebach, The Foundry. Bottom—Dinner groups enjoy a hearty meal.

AMERICAN FOUNDRYMAN

Bowring, Frederic B. Stevens, Inc., was re-elected treasurer.

New directors include R. G. McElwee, Vanadium Corp. of America; G. Vennerholm, Ford Motor

Co.; G. A. Fuller, Federal Foundry Supply Co.; J. P. Carritte, Jr., True Alloys, Inc.; G. L. Galmish, Michigan Malleable Iron Co.; and C. E. Silver, Michigan Steel Casting Co.

APPRENTICE CONTEST

Features Eastern Canada Last Meeting

By G. Ewing Tait

THE final discussion group meeting of the Eastern Canada and Newfoundland chapter was held April 20, with a record turnout. A feature of the evening was the presentation of the Apprentice Contest prizes and exhibition of the patterns and castings.

The cast iron group met under the chairmanship of E. C. Winsbrow, Canadian Car & Foundry Co., Ltd., and heard two short talks on the roles of nickel, molybdenum and other alloys by W. J. Brown, Robert W. Bartram Ltd., and J. C. Kinsella, Dominion Engineering Works Ltd. Both emphasized the fact that alloys should not be used to make poor iron good, but to make good iron better and thus extend its range of usefulness. The discussion centered around the use of a comparatively new alloy, tellurium.

A. E. Cartwright, Robert Mitchell Co., Ltd., was the chairman of the bronze group and R. Galarneau and E. G. Jennings, Dominion Engineering Works Ltd., were the discussion leaders. The topic was "Melting Practice and Furnace Operation" and the basic principles of good melting practice were first outlined. Following this there was a wide expression of opinions on the relative merits of different melting mediums and practices favored by the foundrymen present.

The steel group chairman was P. P. S. Chapman, Canadian Car & Foundry Co., Ltd. Two topics were presented for discussion—C. E. Judson, Canadian Car & Foundry Co., Ltd., talking on melting practices and R. Thompson, of the same company, on heat treatment of steel castings. Mr. Judson's talk was illustrated with a sectional model of a basic open hearth furnace. Most of the discussion dealt with methods of

measuring metal temperatures in electric furnaces.

The Apprentice Contest, run for the second year, aroused a great deal of interest, twenty-six patternmaker and twenty-one molder apprentices taking part. The contest was arranged by the Educational Committee, under the chairmanship of Henri Louette, Warden King, Ltd. Thanks to the cooperation of H. F. Beaupre and A. Dussault the contest was run off in the foundry and pattern shop of the Montreal Technical School.

The products on exhibition at the meeting showed a high standard of workmanship and were the objects of many complimentary remarks.

Henri Louette described the objects of the contest, and the way in which it was carried out before introducing the winners. In every case a leading representative of the firm employing the various winners was there to present the prize to his apprentice, and offer a few words of encouragement.

Prizes were awarded to the following boys as winners of the patternmaking contest: G. Lepage, Cana-

dian Allis Chalmers, Ltd.; M. Bourdua, Canadian Pacific Railway, Angus Shops; R. Tontini, Montreal Technical School; J. Montpetit, Canadian Pattern & Woodworking Co.; and E. MacKenzie, Canadian National Railway, Pt. St. Charles Shop.

Winners who were awarded prizes in the molding contest were: R. Daniel, Beloeil Foundry, Ltd.; E. Doucet, Canadian National Railway, Ft. St. Charles Shop; H. Lalonde, Montreal Foundry, Ltd.; and C. Crevier, Canadian Car & Foundry Co., Ltd., Steel Foundry Div.

The winners of this contest will be invited to make the standard pattern and casting to compete in the National Apprentice Contest.

Lee Gives Accounting Lecture at Indianapolis

By Robert Langsenkamp

WARNING the local foundrymen about the fast approaching cancellations of Government contracts, Ralph Lee, Grede Foundries, Inc., Milwaukee, Wis., presented an enlightening lecture at the Central Indiana chapter's May meeting.

Mr. Lee pointed out the disadvantages of foundries quoting on a "flat price" basis for castings of all types. He told the men to observe closely their operating expenses and overtime wages and urged the use of correct accounting procedures.

The election of officers and directors for the Central Indiana chapter include the following men: *Chairman*, R. S. Davis, National Malle-



S. D. Russell, Phoenix Iron Works (left) and Wm. Butts, General Metals Corp., pose for the cameraman at a Northern California chapter meeting.

able & Steel Castings Co., Indianapolis; *Vice-Chairman*, J. P. Lentz, International Harvester Co., Indianapolis; *Treasurer*, Harold Henniger, International Harvester Co., Indianapolis; *Secretary*, Robert Langsenkamp, Langsenkamp Wheeler Brass Works, Inc., Indianapolis, and *Directors*, H. H. Lurie, Cummins Engine Co., Columbus; W. Tragarz, International Harvester Co., Richmond; G. C. Dickey, Harrison Steel Castings Co., Attica, and L. Snyder, Hickman, Williams & Co., Cincinnati.

Nor. Ill.-Sou. Wis. Holds First 'Old-Timers' Night

By H. W. Miner

TWENTY "old-timers" were honored by members and guests of the Northern Illinois-Southern Wisconsin chapter May 8, at the Faust hotel, Rockford, Ill. The "old-timers," seated at a long table, were given the A.F.A. 50-year pin by chapter officers and directors. Every man present was then requested by Chairman R. W. Mattison, Mattison Machine Works, Rockford, Ill., to file past the "old-timers" and shake the hand of each man.

Chairman Mattison then announced the names of the officers and directors who would serve the chapter next year. Those elected are as follows: *Chairman*, John R. Cochran, Sundstrand Machine Tool Co., Rockford, Ill.; *Vice-Chairman*, Gunnard Anderson, W. L. Davey Pump Co., Rockford, Ill.; *Secretary-Treasurer*, A. P. Rose, National Sewing Machine Co., Belvidere, Ill.; and *Directors*, G. F. Bucholtz, Beloit Foundry Co., Beloit, Wis.; John N. Johnson, J. I. Case Co., Racine, Wis.; and R. W. Mattison.

Cement Patternmaking Explained by Chambers

By J. Ralph Turner

OUTLINING some of the uses of gypsum plaster in foundry work, Fred Chambers, district manager, National Gypsum Co., Luckey, O., gave an informative lecture on "Gypsum Cement Patternmaking" before the Western New York chapter at their May 4 meeting. Mr. Chambers began his talk with a description of gypsum rock mining

and processes used to make gypsum plaster. Directions were given for the proper mixing procedure of plaster when used for various kinds of work. The results of mixing plaster with too much or too little water also were given. Expansion characteristics of plaster were explained as well as the proper use of retarders and accelerators.

The following slate of officers and directors were nominated for the 1945-46 chapter season: *Chairman*, A. H. Suckow, The Symington-Gould Corp., Depew; *Vice-Chairman*, H. C. Winte, Worthington Pump & Mach. Corp., Buffalo; *Secretary*, L. A. Merryman, Tonawanda Iron Corp., North Tonawanda; *Treasurer*, M. W. Pohlman, Pohlman Foundry Co., Inc.; *Directors*, J. C. Goetz, Acme Steel & Malleable Iron Works, Buffalo; F. T.

McQuillin, Standard Buffalo Foundry, Inc., Buffalo; A. J. Heysel, E. J. Woodison Co., Buffalo; and R. D. Loesch, Lake Erie Foundry Co., Buffalo.

Alloy Castings Problems Are Covered by Young

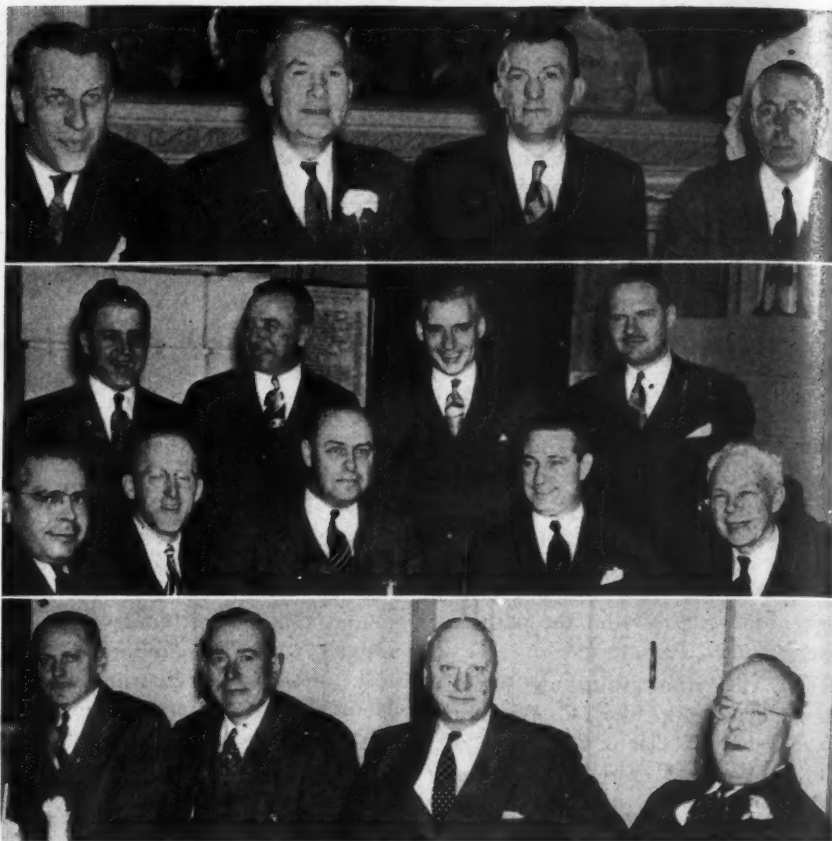
By G. Ewing Tait

A COMPLETE and up-to-date talk on "Prospects and Problems for Light Alloy Castings" in which G. M. Young, chief metallurgist, Aluminum Co. of America, Ltd., Kingston, Ont., pointed out that this is a "light metal age" was presented to the Eastern Canada and Newfoundland chapter at their March meeting.

Mr. Young emphasized that light metals are being used to increase

(Continued on page 80)

AMERICAN FOUNDRYMAN



Pictures snapped at the May 11 meeting of the Rochester chapter when "Jim McHenry Night" was held. Top—Seated at the speaker's table (left to right) L. C. Gleason, Gleason Works; J. E. McHenry, Gleason Works, 50-year foundry veteran and chapter's guest; Chapter president W. F. Morton, The Anstice Co., Inc.; and N. L. Smith, Link-Belt Co., Philadelphia, Pa., guest speaker. Center—Some of the boys who "whooped it up" for Jim McHenry (seated, left to right) H. S. Carr, Whiting Corp.; W. J. Venus and C. H. Rupp, Jewell Alloy & Mall. Co., Inc.; and A. Lochte and E. C. Seiser, American Laundry Mach. Co. (Standing, left to right) M. F. Gentner, Sargent & Greenleaf, Inc.; L. H. Wells, N. Ransohoff, Inc.; D. L. Hayes, Laverack & Haines; and L. C. Thellemann, Inter-Allied Foundries of New York State. Bottom—Part of the chapter membership who heard N. L. Smith's technical talk are (left to right) W. G. Brayer, Bausch & Lomb Optical Co.; H. G. Hetzler, Hetzler Foundries, Inc.; R. T. Melville, Henna Furnace Co.; and H. B. Hanley, American Laundry Mach. Co.

THE LAST *DROP* IS AS
GOOD AS THE FIRST



*Ask the
Men Who
Use It!*



A GRINDING QUESTION

What's the use of spending a lot of money for the best foundry equipment if you don't use the **BEST** core oil you can buy? You don't take chances with **DAYTON Core Oil**! This dependable, uniform, unvarying quality oil assures you of 100% efficiency in the core room. Let the trained **DAYTON OIL Service** man give you the benefit of his long experience.

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STEEL CORE AND MOLD WASHES - BINDER AND CORE PASTE - CORE WASHES - CHILL COATINGS



TO THE MARITIME INDUSTRY

FOR

Distinguished Service

The reply of American industry to the challenge of Brutalitarianism has been a deluge of production never before achieved by any nation in the history of mankind.

A significant share of the credit for this amazing record of accomplishment should be given to our Maritime Industry which, since Pearl Harbor, has produced a tonnage of vessels that will live forever as an epic of Yankee ingenuity. Federated is proud to salute every individual in the Maritime Industry for this magnificent job!

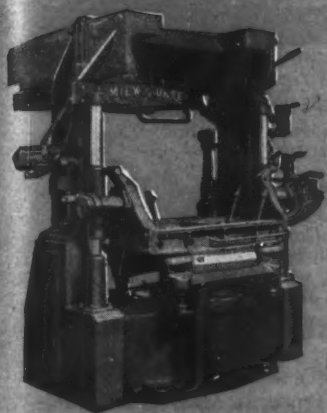
And proud, too, that since the start of the war, nearly two billion pounds of Federated non-ferrous metals have been supplied to the shipbuilding and other American industries to help speed the day of ultimate victory.



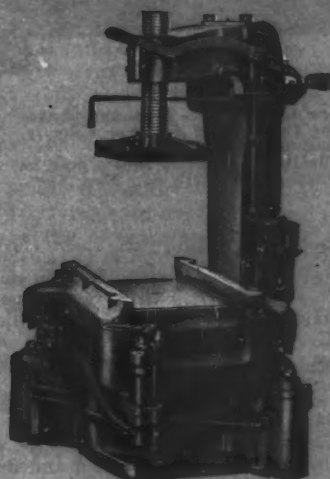
ONE OF A SERIES OF ADVERTISEMENTS DEDICATED TO THE PRODUCTIVE ROLE OF AMERICAN INDUSTRY IN WORLD WAR II.

Milwaukee Molders

Designed • Built • Sold and Serviced by Experienced Foundrymen



Jolt Squeeze Rollover Draw



Jolt Squeeze Stripper



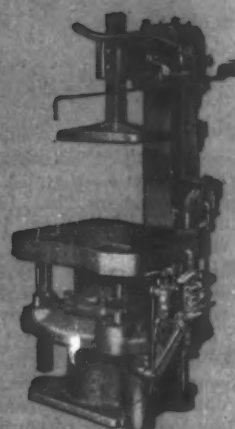
Jolt Squeeze Stripper
with Mold Lift Off



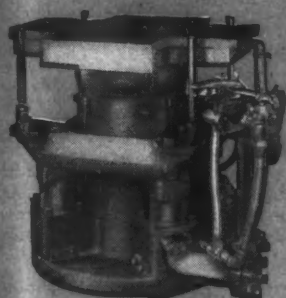
Jolt Squeezer
—Also Stationary Type



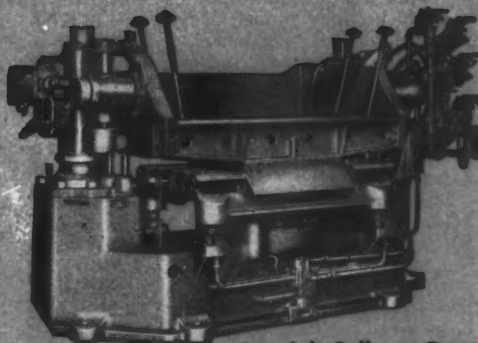
Plain Jolt
Made in All Sizes.



Jolt Squeeze Pin Stripper
Small Size, also Portable



Jolt Pin Lifter



Jolt Rollover Draw



Power Rail Push-Off

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3238 W. PIERCE STREET,



Foundry Equipment Co.

MILWAUKEE 4, WISCONSIN, U.S.A.

Abstracts



NOTE: The following references to articles dealing with the many phases of the foundry industry, have been prepared by the staff of *American Foundryman*, from current technical and trade publications. When copies of the complete articles are desired, photostat copies may be obtained from the Engineering Societies Library, 29 W. 39th St., New York, N. Y.

Aluminum-Base Alloys

ANALYSIS. (See *Spectrochemical Analysis*.)

HIGH STRENGTH. "Some High-Tensile Aluminum Casting Alloys," J. Morgan, *FOUNDRY TRADE JOURNAL*, March 8, 1945, vol. 75, no. 1940, pp. 189-194.

An abstract of a paper, read before the Wales and the Monmouth Branch of the Institute of British Foundrymen, which considers different types of aluminum-base alloys which have or can develop good tensile properties.

Brass and Bronze

CASTING PROCEDURE. (See *Copper-Base Alloys*.)

Casting Methods

CONTINUOUS CASTING. "Symposium on Continuous Casting," A.I.M.E. Technical Publication No. 1793, *METALS TECHNOLOGY*, February, 1945, vol. 12, no. 2, 46 pp.

This symposium is a report of a joint session on continuous casting held by the Institute of Metals Division and the Iron and Steel Division of the A.I.M.E.

The symposium was opened by Carl E. Swartz, who introduced the speakers and conducted the discussions. The background and history of continuous casting were covered by two papers—"Continuous Casting Yesterday and Today," by T. W. Lippert, and "Continuous Casting of Metals—History, Requirements, Metallurgy, and Economics," by Norman P. Goss. C. W. Hazlett presented a paper on "Improvements in the Direct Casting of Strip Metals." Detailed discussions of particular processes of continuous casting were presented in "The Soro Process," by E. J. Valyi, and "The Williams Process of Casting Metals," by E. R. Williams.

Chemical Analyses

SPOT TESTS. (See *Nickel-Base Alloys*.)

POLAROGRAPHIC. "Polarography," G. W. Birdsall, *STEEL*, March 5, 1945, vol. 116, no. 10, pp. 122-123, 162, 164, 167-168, 170, 172.

Description and applications of a comparatively new and extremely sensitive method of chemical analysis. Analyses are effected by interpreting current-voltage curves obtained from an electrolytic cell with a dropping mercury electrode. The metal to be analyzed is put in solution and placed in the cell.

Copper-Base Alloys

CASTING PROCEDURE. "Metallurgy in the Non-Ferrous Foundry," VII. Casting the High Shrinkage Metals and Alloys, A. C. Boak, *CANADIAN METALS AND METALLURGICAL INDUSTRIES*, March, 1945, vol. 8, no. 3, pp. 23-26.

Methods of melting, fluxing, gating, risering, and pouring recommended for the production of castings of copper, silicon bronze, aluminum bronze, and manganese bronze.

Inspection

TESTING METHODS. "Testing Castings," *CANADIAN METALS AND METALLURGICAL INDUSTRIES*, March, 1945, vol. 8, no. 3, pp. 31-36.

This article consists of four papers presented at the February 23 meeting of the Ontario Chapter of the A.F.A., at which the subject for the meeting was "Testing Castings."

The papers presented were "Steel," by Walter Crafts; "Trouble Shooting Malleable," by M. E. McKinney; N. C. MacPhee; and "Testing Castings (Non-Ferrous)," by A. C. Boak. The steel and malleable papers are presented in full. However, since many testing procedures are applicable to all types of castings, the gray iron and non-ferrous papers were condensed in order to avoid repetition.

Nickel-Base Alloys

SPOT TESTS. "Identification of Nickel Alloys by Spot Tests," *METAL PROGRESS*, March, 1945, vol. 47, no. 3, pp. 510, 627.

Spot test procedures which will distinguish between monel, "S" monel, "K" monel, nickel, "D" nickel, 30% copper-nickel, nickel silver, inconel, chromium-iron and chromium-nickel stainless steels, Ni-resist, ordinary steel, and cast iron.

Non-Ferrous Alloys

RECENT DEVELOPMENTS. "Some Recent Developments in Engineering Materials," Archibald Black, *MECHANICAL ENGINEERING*, March, 1945, vol. 67, no. 3, pp. 190-198.

The second installment of an article describing recent materials and processes. Included in this installment are discussions of aluminum, magnesium, and beryllium alloys; porous-chromium surfacing; die casting materials and practices; tin and lead coatings on steel; tinless solders; silver bearing and other babbitts; copper-brazing methods; laminated metals; high-nickel alloys; investment castings; calcium; indium; and lithium.

Following the discussion is a bibliography on the foregoing subjects.

Non-Ferrous Castings

TESTING METHODS. (See *Inspection*.)

Patterns

PATTERNMAKING. "Some Patternmaking Considerations," R. L. Simpson, *FOUNDRY TRADE JOURNAL*, February 22, 1945, vol. 75, no. 1488, pp. 153-156.

A practical consideration of some of the essentials of patternmaking.

Quality Control

STATISTICAL METHODS. "Quality Control," B. P. Dudding and W. J. Jennett, *METAL INDUSTRY*, March 2, 1945, vol. 66, no. 9, pp. 130-133; March 9, 1945, vol. 66, no. 10, pp. 146-149.

An article based on a lecture given to the London Section of the Institute of Metals.

In the first installment, the authors explain how the probable variation of a property may be determined, so that examination of a small number of samples will indicate the quality of the entire product.

In the second installment the authors discuss the application of the theory of probability to metallurgical control, the analysis of variance and variability of measurement.

Spectrochemical Analysis

ALUMINUM-BASE ALLOYS. "The Rapid Evaluation of Aluminum Alloys by Spectrochemical Analysis," J. Kenneth C. Peer, *LIGHT METAL AGE*, February, 1945, vol. 3, no. 2, pp. 12-13, 23.

The author explains that spectrochemical analysis is a much more rapid method than wet chemical analysis for determining whether impurities in aluminum-base alloys exceed the maximum percentage tolerances specified for those alloys.

Steel

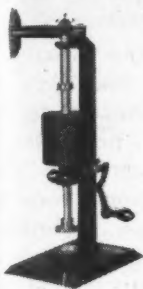
BORON. "Effect of Boron on Machinability and Hardenability," T. G. Harvey, *THE IRON AGE*, February 15, 1945, vol. 155, no. 7, pp. 52-54.

The report of an investigation of the effects of boron on medium carbon steel shows that boron increases the hardenability and decreases the machinability.

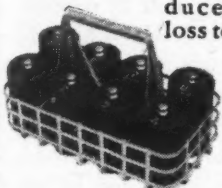
CONVERTER. "Bessemer Steel Production and Application," *THE IRON AGE*, March 22, 1945, vol. 155, no. 12, pp. 59-65.

A symposium on bessemer steels conducted at a recent Pittsburgh chapter meeting of the American Society for Metals. Papers presented at the symposium were "Dephosphorized Bessemer Steel," by Gordon Yacum; "Killed Bessemer Steel," by E. C. Wright, and "Future of Bessemer Steel for Automatic Screw Machine Parts," by J. D. Armour.

AMERICAN FOUNDRYMAN



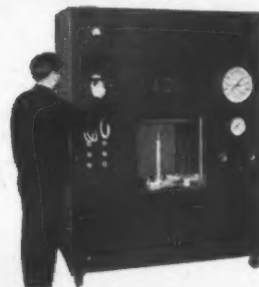
SAND RAMMER (left) standard for ramming specimens of molding sand and cores for the AFA green and dry permeability test and all standard strength tests.



SAMPLE TRAY (below) for transporting sand samples to laboratory. Reduces moisture loss to a minimum.

REDUCE SCRAP LOSSES

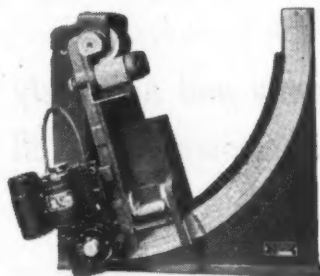
PREPARE YOUR FOUNDRY for postwar competition by installing a practical sand control program to *reduce scrap losses*. We are able to supply you with the equipment necessary to carry out this program. This can be accomplished with little effort and a surprisingly small investment. Write us describing your available sand preparing equipment, type and size of castings and tonnage. *We will be glad to give you our recommendations for a suitable sand control program.*



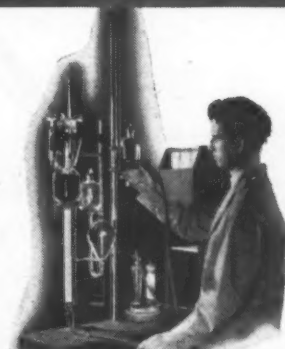
THE HITEMP DILATOMETER You can be sure of better castings by knowing how your sands behave at pouring temperatures. The Dilatometer makes available both the visual as well as the physical testing of all molding materials at temperatures and conditions which prevail in the mold at the time the metal is poured. Two models now available.

MOISTURE TELLER Will dry a fifty gram sample of high permeability molding sand in one minute by

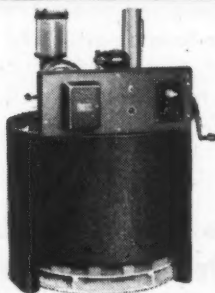
forcing electrically heated air through the test sample. Test is in exact moisture percentage by gravimetric method. No calibrations are required. *Operating cost is very low.*



UNIVERSAL SAND STRENGTH MACHINE WITH MOTOR DRIVE . . . Performs a wide variety of strength tests on molding sands, clays, cores and core pastes. You can obtain accurate results with this sturdy and reliable unit with a minimum amount of personal attention.

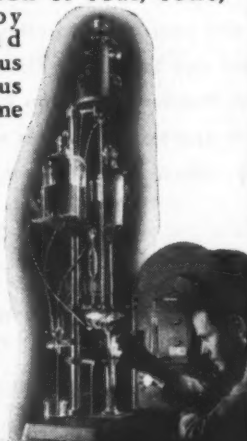


2-MINUTE CARBON DETERMINATOR enables you to determine either preliminary or final carbon content of all metals with speed and accuracy. Complete determination can be made *within 2 minutes* after sample is weighed.

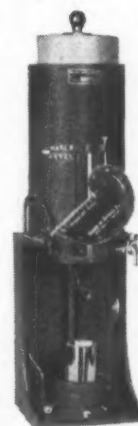


TEST CORE BAKING OVEN . . . This sturdily constructed, electrically heated oven, bakes test cores or dry sand specimens entirely by convected heat. Ideal for determining the strength of core oils, binders or the quality of core sands.

TWO MINUTE SULFUR DETERMINATOR Provides rapid and accurate sulfur determination of coal, coke, irons, alloy steels and other ferrous or non-ferrous materials. Time required for a complete analysis, exclusive of weighing samples, is 2 minutes. For both preliminary and final sulfur determinations.



PERMEABILITY METER You can make accurate shop control permeability readings within 15 seconds with the Permeability Meter. Widely used for measuring green, dry and baked A.F.A. permeability of molding sands, cores and molds. Use the Permeability Meter to improve sand conditions in your foundry.



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9330 ROSELAWN

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ELEMATIC THERMOCOUPLE

MODEL 4000 — for wall type indicator or recorder. Has flexible arm adjustable to any angle without use of tools.

For Instantly and Accurately Checking the Temperature of all Nonferrous Molten Metals

Everyday, an increasing number of foundries are adopting the more efficient *Elematic Thermocouples*. Not only because they give such dependable temperature control, but because they are more economical.

All *Elematic Thermocouples* are equipped with our own, exclusive *Metalast Protection Tubes*—long life tubes which can be easily replaced without damaging or discarding the thermocouple, and at a saving of time and labor.

Made of a special heat resisting alloy, in types for both furnace and ladle use, *Elematic Thermocouples* with *Metalast Protection Tubes* have been tested and approved by scores of the largest brass and copper foundries in America.

Write for Our Latest
Bulletin AF-500

DOUBLE THE LIFE OF YOUR THERMOCOUPLES WITH THIS REPLACEABLE METALAST TUBE

Simple to attach . . . fully protects thermocouple from slag or molten metal . . . drilled from solid special alloy stock without welds or seams. Available in 6" or 8" lengths with 1/2" pipe thread.

ELEMATIC EQUIPMENT CORP.

6046 WENTWORTH AVENUE, CHICAGO 21, ILLINOIS

CHAPTER ACTIVITIES

(Continued from page 74)

speeds and efficiencies through reduced weights of machinery and equipment. He described the outstanding physical properties of aluminum and magnesium alloys and their applications correlated with their properties. A brief account was given of the inherent difficulties in the production of light metal castings, such as porosity and micro-shrinkage. He outlined some of the methods which have been developed for the elimination of these difficulties.

The speaker concluded his remarks with a discussion of postwar fields in which light metals will play a prominent part.

Firebrick Holds Good War-Time Record

By C. E. Rothweiler

GREAT strides have been made in the last five years in the making of fire brick, according to Cecil E. Bales, vice-president, Ironton Fire Brick Co., Ironton, O. Mr. Bales, chairman, A.F.A. Refractories Committee, was the guest speaker at the St. Louis District chapter, April 12. The lecturer went on to tell an interested crowd the comparative qualities of fire brick made today as that manufactured during the last war. The industry is proud of its wartime record, stated Mr. Bales, as they have been able to fulfill all their wartime obligations.

Kane Talks to Michiana On Foundry Dust Control

By C. W. Peterson

BEFORE a packed house, John N. Kane, American Air Filter Co., Louisville, Ky., presented a technical paper on the "Control of Dust in Foundries." This subject was well received by members of the Michiana chapter at the regular meeting held April 3, at the Hotel La Salle, South Bend, Ind.

Announced at this time were the new chapter officers and directors elected to office: *Chairman*, W. V.

(Continued on page 89)

AMERICAN FOUNDRYMAN

"New Sources of Labor Supply were opened up for our foundry"

An eastern foundry was almost at the end of its rope. Only the huskiest kind of men were able to handle its 100 to 150 lb. loaded flasks—only strong men could lift them—let alone turn them over to shake-out the sand. And the available supply of strong men was dwindling fast.

A Robins Portable Floatex Shakeout was purchased; that took care of the shaking-out. But there was still the matter of lifting the loaded flasks to the deck of the machine. So a Special Flask Loader was created—an auxiliary device that took over all the labor of removing the flask from the foundry floor and depositing it on the feeding table.

Now, any kind of help can be employed—young boys, lightweight men . . . even an ex-chauffeur over 60 years old! As the superintendent remarked, "New sources of labor supply were opened-up for our foundry when that Portable Floatex with its flask loader went to work in our shop."

Floatex Shakeouts have solved many difficult problems in foundries of all types and sizes all over the country. They are adaptable to every kind of casting requirement: grey iron, steel, brass, manganese and aluminum. They are genuinely full-floating—gentle to flasks and castings. They have no vulnerable eccentric shafts or outboard bearings to snap or break under load. They require no massive foundations to absorb vibration. Floatex Shakeouts shake the flask—not the building.

Full facts are contained in Bulletin 124—AF6. A copy will be sent free on request.

MEMBER



Floatex Shakeouts are made in Standard models (self-discharging and non-discharging, single and multiple units) to handle loaded flasks weighing up to 100 tons or more. In Portable models (with and without flask loaders) for flasks up to 17 tons.

ENGINEERS, MANUFACTURERS AND ERECTORS OF MATERIALS HANDLING MACHINERY

ROBINS makes: BELT CONVEYORS • COAL AND ORE BRIDGES • BUCKET ELEVATORS • CAR AND BARGE HAULS • CAR DUMPERS • CAR RETARDERS • CASTINGS • CHUTES • CONVEYOR IDLERS AND PULLEYS • CRUSHERS • FEEDERS • FOUNDRY SHAKEOUTS • GATES • GEARS • GRAB BUCKETS • PIVOTED BUCKET CONVEYORS • VIBRATING SCREENS • SCREEN CLOTH • SELF-UNLOADING BOAT MECHANISMS • SKIP HOISTS • STORAGE AND RECLAIMING MACHINES AND SYSTEMS • TAKEUPS • LOADING AND UNLOADING TOWERS • TRIPPERS • WEIGH LARRIES • WINCHES • WINDLASSES

FOR MATERIAL AID IN MATERIALS HANDLING It's ROBINS



The flask is gripped by the loader ready to be raised mechanically.



The loader does all the lifting; the man merely guides the path of travel.



Electric power returns the tongs so they can pick up the next flask while the Floatex shakes-out the one just delivered.

ROBINS
CONVEYORS
INCORPORATED
Founded in 1896 as Robins Conveying Belt Co.
PASSAIC • NEW JERSEY

STURTEVANT FOUNDRY SHAKEOUT SYSTEM

*gives you
these advantages:*

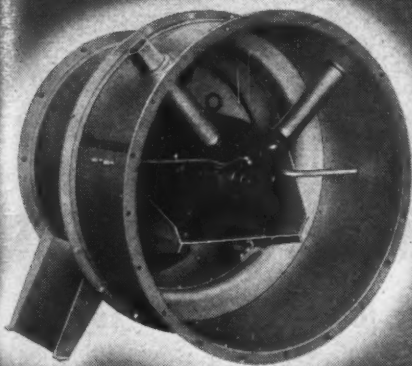
1. Worker efficiency increased—by elimination of an occupational hazard.
2. Equipment efficiency increased and maintenance reduced—by control of abrasive dust.
3. Cleaning costs reduced—by removal before dust and vapors can enter the room air.
4. Insurance risk reduced—by banishing a source of occupational disease.

BEFORE—This is the dust storm one customer had around the Foundry Shakeout—before installing a Sturtevant System. It was a menace to health and equipment.

*You can make dollars
out of AIR—here's how...*

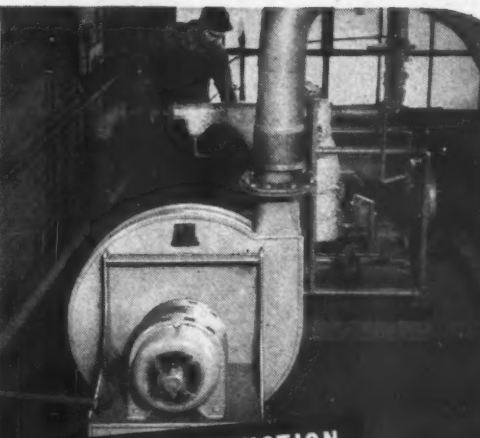


AFTER—Now see the difference! That dust is whisked off as soon as it is stirred up. A serious health hazard banished—cleaning eliminated—maintenance reduced.



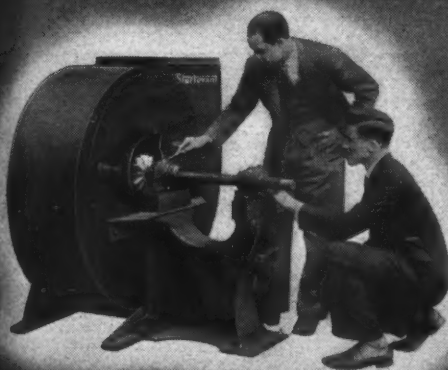
SMOKE AND FUME REMOVAL

For example—compact Sturtevant axial flow pressure fan with self-ventilated motor handles dust laden air up to 250", possesses over 79% mechanical efficiency—saves space and power.



AIR FOR COMBUSTION

For example—Under varying loads, temperature was hard to control in annealing furnaces. Now—with a Sturtevant Compressor—pressure of air to burners is held constant automatically, whatever the volume. Power is saved in proportion to the air used.



CORE OVEN FANS

For example—Down-time, due to overheating of fan shafts, has been eliminated since Sturtevant Planovane Fans went in. Equipped with a special "heat slinger" on the main shaft it costs nothing to operate—eliminates the need for water-cooled bearings.



CUPOLA BLOWERS

For example, Switching to a Sturtevant Cupola Blower and controlling the air by weight paid for itself within a year—with higher iron-coke ratios, faster melting rate, improved micro-structure of castings.

CUPOLA BLOWERS

SMOKE AND FUME REMOVAL

CORE OVEN FANS

FOUNDRY SHAKEOUT SYSTEM

DUST CONTROL

Yes, the way you use (or don't use) AIR in the plant may be costing you plenty. But it can be made to pay big dividends! By turning to *engineered air* the Sturtevant way, foundries have increased production rates, improved quality of castings, reduced wear on equipment, slashed plant cleaning costs. All that means real money savings—as these typical examples show.

And remember, whether it is a cupola blower or complete ventilating system, *your* air requirements need individual study—if you are going to obtain utmost efficiency, biggest dollar savings. Why not discuss your plant air problems with one of our experienced specialists? He will gladly give you up-to-the-minute advice and the expert cooperation you need to *get dollars from air*.



B. F. STURTEVANT COMPANY
Hyde Park Boston 36, Mass.

Sturtevant

REG. U. S. PAT. OFF.

Puts Air to Work

Metal Abrasives

that Clean Faster! Do the job Better! Last Longer!

IMMEDIATE DELIVERY IN ALL SIZES!

- *Hard and uniform* best describes "Par Grit" and "Sure Shot" steel abrasives. For blast cleaning they're unequalled because they're scientifically heat treated by a special process which makes each pellet hard, uniform and tough. Foundries insist on Western Metal Abrasives . . . they guarantee longer life plus quick, positive cleaning action. 100-lb. Bags—Ton and Carload lots available.

GUARANTEED ACCURATE SIZES . . . GRADED TO THE NEW S. A. E. SPECIFICATIONS

The Western Metal Abrasives Co.

Plant: Chicago Heights, Illinois

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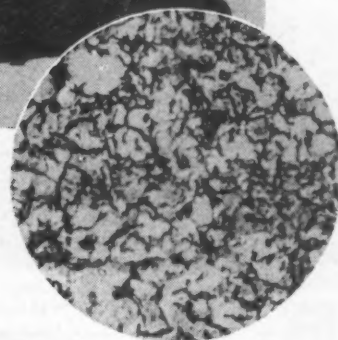
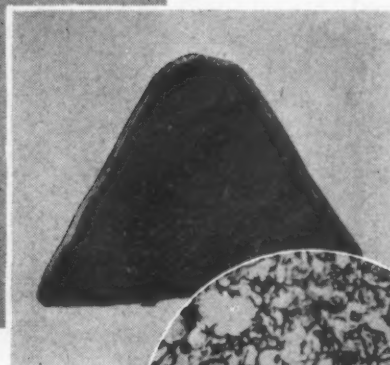
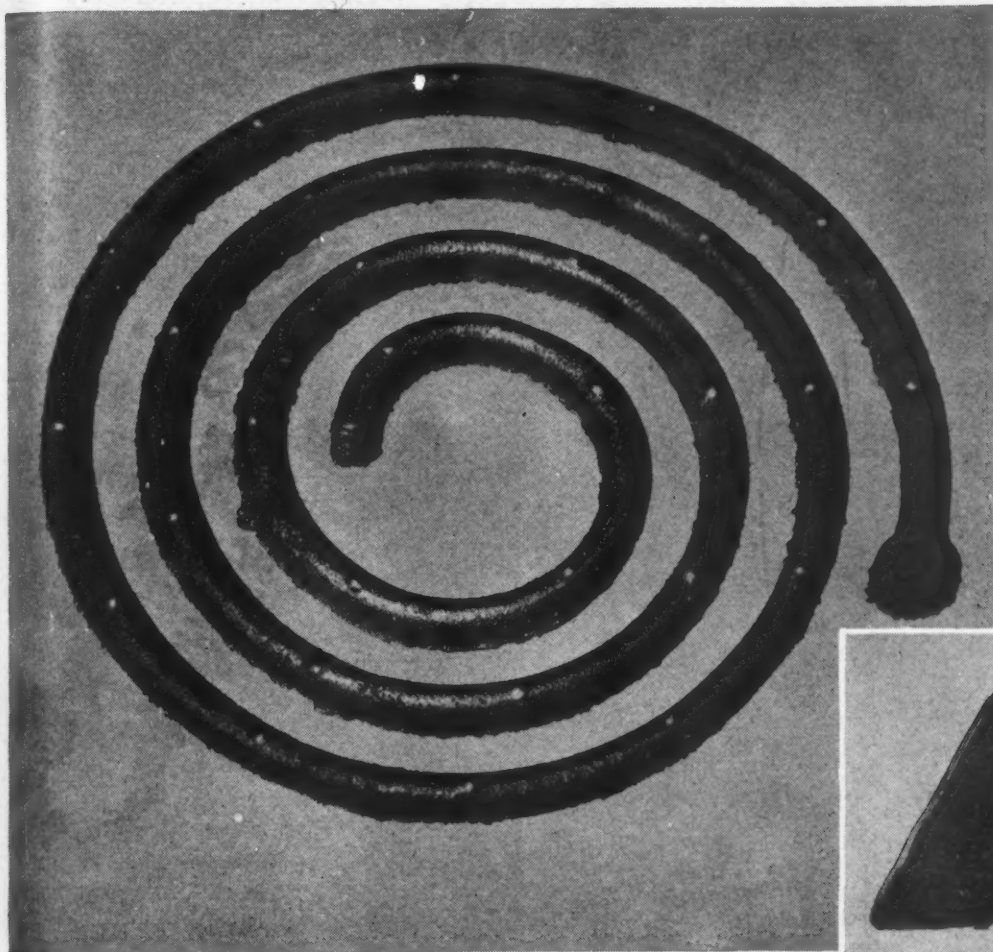
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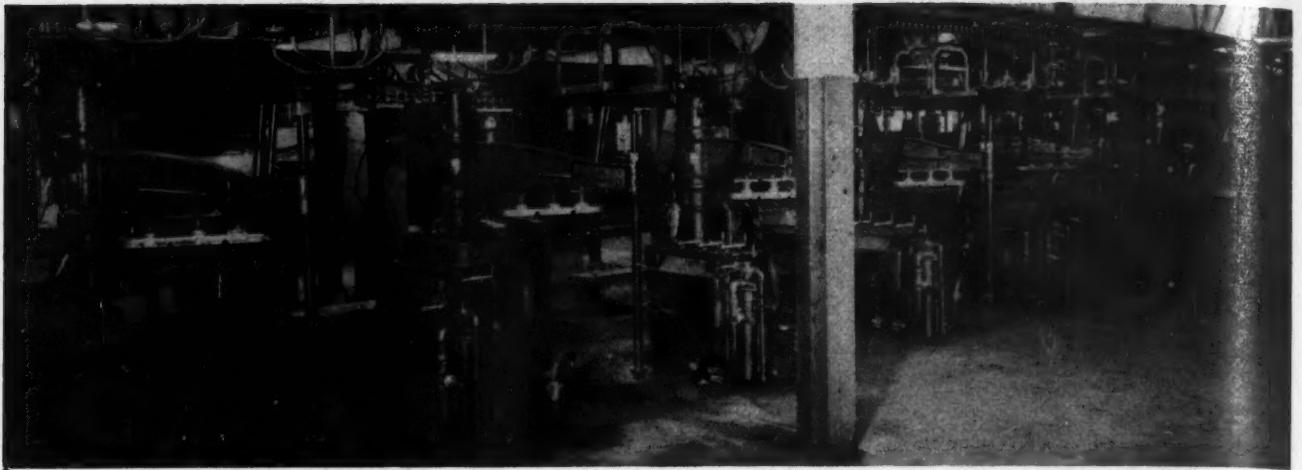
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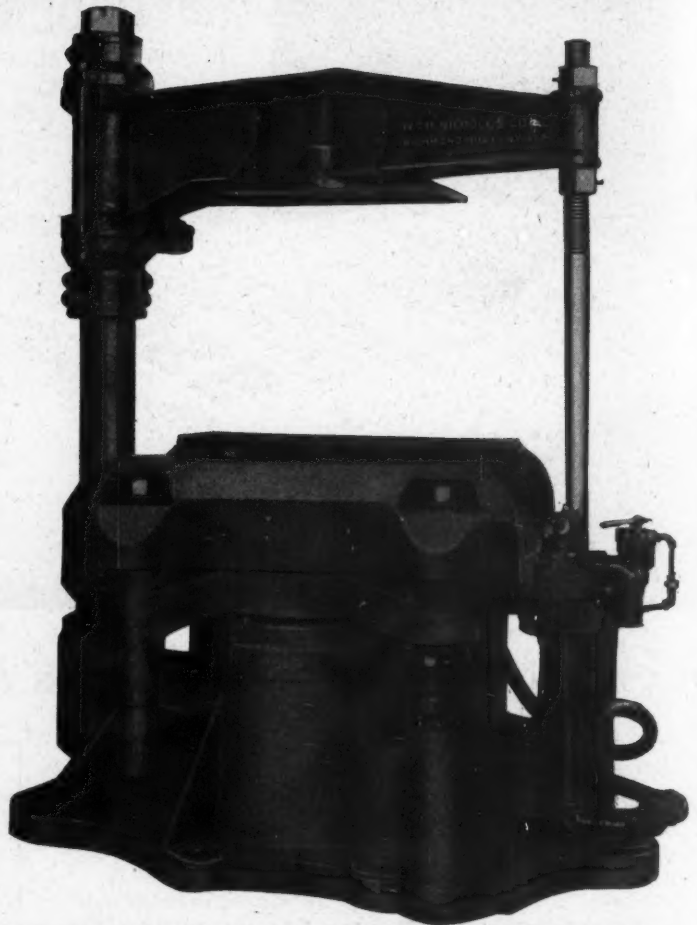


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NICHOLLS

CHAPTER ACTIVITIES

(Continued from page 80)

Johnson, Oliver Farm Equipment Co., South Bend; *Vice-Chairman*, John McAntee, Covell Mfg. Co., Inc., Benton Harbor, Mich.; and *Secretary-Treasurer*, V. S. Spears, American Foundry Equipment Co., Mishawaka, Ind.

Directors elected for three year terms included: John MacDonald, Round Oak Furnace Co., Dowagiac, Mich.; G. O. McCray, Bendix Products Div., South Bend; J. E. Digan, Logansport Radiator Equipment Co., Logansport; and M. F. Surls, Clark Equipment Co., Buchanan, Mich. H. E. Ardahl, Michiana Products Co., Michigan City, was elected a director to serve the unfinished term of John McAntee.

This was the final meeting of the Michiana chapter and they will resume activities in the Fall.

Old Timers Honored by Northeastern Ohio Chapter

By William G. Gude

ANNUAL "Old-Timers" night of the Northeastern Ohio chapter, held May 10 at the Cleveland club, attracted a record attendance. A total of 105 men were present with foundry service records showing 40 years or more. Dean of this group was A.F.A. Past President Ben D. Fuller, Whitehead Bros. Co., with 64 years of service, followed by G. H. Zimmerman, Eberhard Mfg. Co. Div., with 63 years; J. V. Horning, Ohio Foundry Co., 61 years; Henry M. Oehling, National Malleable & Steel Castings Co., Cleveland, 58 years, and E. Renk, Eberhard Mfg. Co. Div., 57 years. Among the guests present were 20 apprentices from the Cleveland Trade School.

At this meeting Chairman Russell F. Lincoln, Russell F. Lincoln & Co., Cleveland, announced the following men to serve as chapter officers and directors for the coming year. To serve as *Chairman*, A. C. Denison, Fulton Foundry & Machine Co., Inc., Cleveland; *Vice-Chairman*, Henry J. Trenkamp, Ohio Foundry Co., Cleveland; *Secretary*, Gilbert J. Nock, Nock Fire Brick Co., Cleveland, and *Treasurer*, F. Ray Fleig, Smith Facing & Supply Co., Cleve-

JUNE, 1945

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land. Elected for three years as Chapter *Directors*: Leon Miller, Osborn Mfg. Co., Cleveland; Dave Clark, Forest City Foundries Co., Cleveland; Tom West, West Steel Castings Co., Cleveland; Edward J. Metzger, Wellman Bronze & Aluminum Co., Cleveland; Frank C. Cech, Cleveland Trade School, Cleveland; and Paul Wheeler, Link-Belt Co., who was elected a director for two years.

Western New York Holds Dance and Bowling Party

By J. Ralph Turner

THE Buffalo Trap and Field Club was the scene for Western New York chapter's spring dinner dance held May 12. After a tasty dinner was served the members and guests danced until the wee hours of the morning.

On the following Friday, May 18, about 80 members gathered at a local bowling alley and enjoyed an evening of good fellowship.


Schleede's Pattern Talk Presented at Twin City

By H. F. Scobie

CHAIRMAN A. M. Fulton, Northern Malicable Iron Co., St. Paul, Minn., conducted the April 24 meeting of the Twin City chapter at the Curtis Hotel, Minneapolis. E. H. Schleede, development engineer, U. S. Gypsum Co., Chicago, Ill., presented his applications of gypsum to foundry practice in an interesting and unique manner. Mr. Schleede divided his talk into applications of gypsum to pattern construction and use of gypsum as a mold material. Time saving in pattern construction and dies for forming aircraft fuselage parts were demonstrated. The working characteristics of gypsum and specific practices used for forming and sweeping patterns were shown.

At the business meeting the following men were elected to hold office for the 1945-46 season: *Chairman*, R. C. Wood, Minneapolis Electric Steel Castings Co.; *Vice-Chairman*, H. M. Patton, American

(Continued on page 92)

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- MACHINE CAST

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Reports on Chapter Activities

Officers and representatives of A.F.A. chapters who report on local activities in this issue are identified below:

Central Indiana—R. Langsenkamp, Langsenkamp-Wheeler Brass Works, Inc., Indianapolis.

Central Ohio—Frank Kiper, Ohio Steel Foundry Co., Springfield.

Chesapeake—E. J. Hubbard, Koppers Co., Baltimore, Md.

Detroit—H. H. Wilder, Vanadium Corp. of America, Detroit.

Eastern Canada and Newfoundland—G. Ewing Tait, Dominion Engineering Works, Lachine, Que.

Metropolitan—George Hadzima, Robins Conveyors Inc., Passaic, N. J.

Michiana—C. W. Peterson, Dodge Mfg. Co., Mishawaka, Ind.

Northeastern Ohio—W. G. Gude, THE FOUNDRY, Cleveland.

Northern California—Richard Vosbrink, Berkeley Pattern Works, Berkeley.

Northern Illinois-Southern Wisconsin—H. W. Miner, Fairbanks, Morse & Co., Beloit, Wis.

Philadelphia—B. A. Miller, Cramp Brass & Iron Founders Div., The Baldwin Locomotive Works, Eddystone, Pa.

Quad City—H. L. Creps, Frank Foundries Corp., Moline, Ill.

Rochester—C. B. Johnson, The Symington-Gould Corp., Rochester.

Saginaw Valley—J. J. Clark, Saginaw Malleable Iron Div., General Motors Corp., Saginaw.

St. Louis—C. E. Rothweiler, Hickman, Williams & Co., St. Louis.

Twin City—H. F. Scobie, University of Minnesota, Minneapolis.

Western New York—J. Ralph Turner, Queen City Sand & Supply Co., Buffalo.

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CHAPTER ACTIVITIES

(Continued from page 90)

Hoist & Derrick Co.; *Secretary-Treasurer*, Alexis Caswell, Manufacturers' Association of Minneapolis, Inc.; *Directors*, H. J. Bierman, Acme Foundry Co.; A. M. Fulton, Northern Malleable Iron Co.; Sheldon P. Pufahl, Paul Pufahl & Son Foundry Co.; and Clifford Anderson, Crown Iron Works Co.

Casting Design Interests Big Crowd at San Francisco

By Richard Vosbrink

A BIG audience, attracted by the subject "Design of Castings," attended the Northern California chapter's final technical meeting held at the Engineers Club, San Francisco, May 11. This program fulfilled an oft expressed desire for a meeting of this type on casting design and George McDonald, H. C. Macaulay Foundry Co., as Special Chairman, had an excellent program worked out.

Charles Winslow, Winslow Engi-

AMERICAN FOUNDRYMAN

neering Co.; Richard Vosbrink, Berkeley Pattern Works, Berkeley; Ray Wilson, Pacific Steel Casting Co., Berkeley; and Henry Hirvo, Enterprise Engine & Foundry Co., served as Mr. McDonald's "cast." Each of the above men were allowed 20 minutes in which to discuss such subjects as engineering, patternmaking, molding and machining of castings. This production was one of the highlights of the year. The time spent in preparing this meeting was worth the effort as both members and guests were amused by some of the questions asked from the floor and the answers given by the "cast."

Cores and 'F Metal' Are Discussed at Central Ohio

By Frank Kiper

A DUAL meeting with Jack Schram, Swan-Finch Oil Co., Columbus, O., and C. R. Wiggins, Ferrous Metals Corp., New York, N. Y., made up the April meeting for the Central Ohio chapter.

Mr. Schram, who spoke on core room problems, gave a detailed analysis of the causes and cures of certain typical core room troubles. He emphasized the fact of weather conditions, time of mixing and viscosity of core oils. The effect of the rate of baking on all core properties, the causes of penetration of core surfaces and the causes and cures of shrinks and cracks also were discussed.

Mr. Wiggins' paper on "F Metal" described its characteristics and post-war possibilities.

Casting Defects Presented By Klopff at Nor. Ill.-S. Wis.

By Howard W. Miner

THE Northern Illinois-Southern Wisconsin chapter met March 13 at the Hotel Hilton, Beloit, Wis., to hear A. S. Klopff, Firegan Sales Co., talk on "Casting Defects." The speaker, who is secretary, A.F.A. Casting Defects Committee, explained the purpose and progress of this committee's work. In his illustrated talk he described numerous types of casting defects explaining their causes and possible ways to correct the condition. The information was well presented and the many

questions put to the speaker during the discussion period showed the importance of his subject.

June Chapter Meetings

June 16

Western New York
Hotel Touraine, Buffalo
ANNUAL MEETING

+

Quad City
Camp Nobel, Moline, Ill.
ANNUAL PICNIC

+

Philadelphia
Hy-Top Country Club

+

June 25

Erie
Moose Club, Erie, Pa.

Service Award Features Chesapeake March Meeting

By Erle J. Hubbard

EMPLOYED for forty years in the foundry industry, Fred Roemer was presented with a pen and pencil set at the March 23 meeting of the Chesapeake chapter. The presentation was made on behalf of the chapter by Ed Horlebein. Fred is retiring from the foundry industry after long and faithful service.

The talk of the evening was made by Max Kuniansky, Lynchburg Foundry Co., Lynchburg, Va., his theme being gray iron foundry practices and problems.

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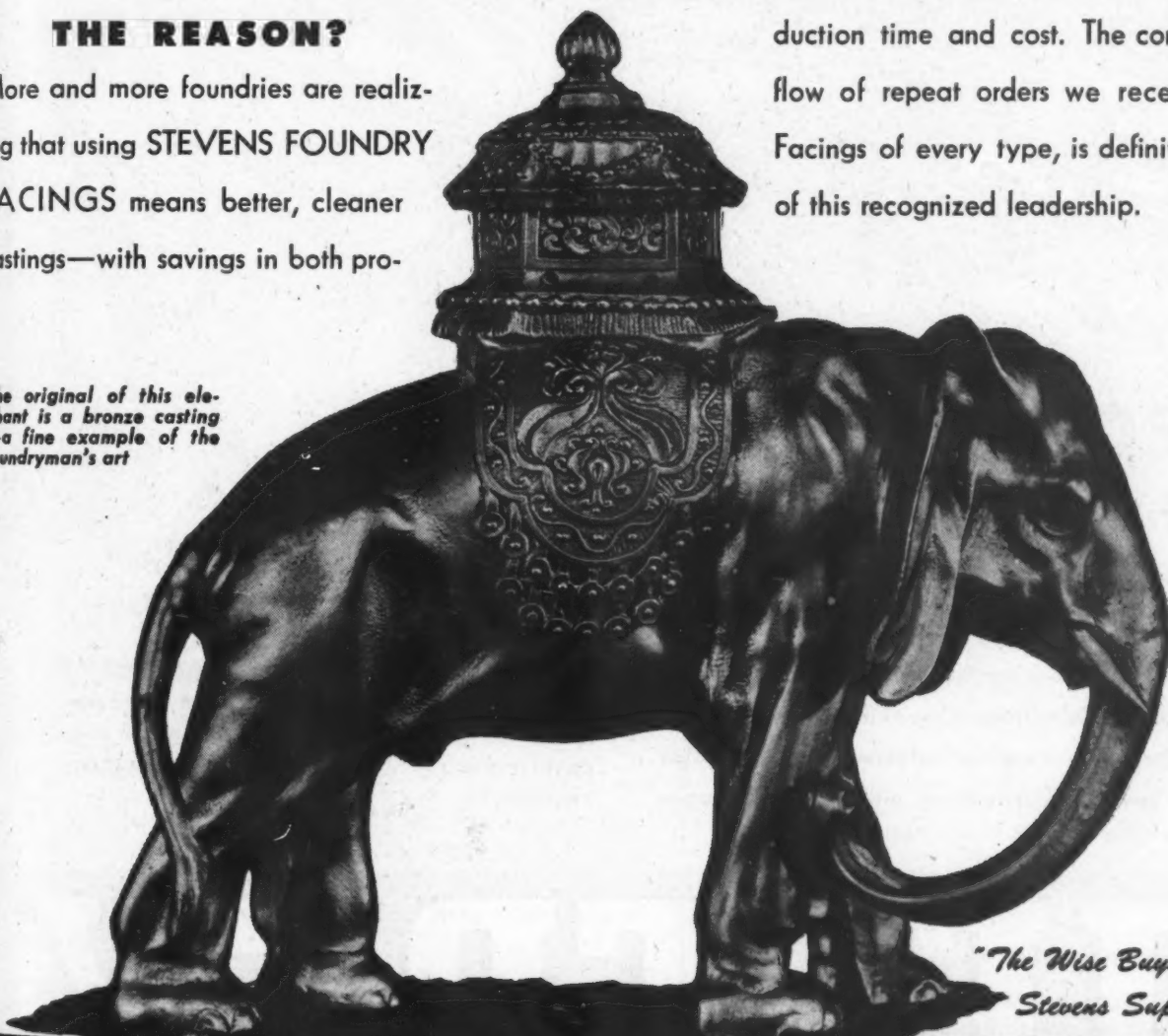
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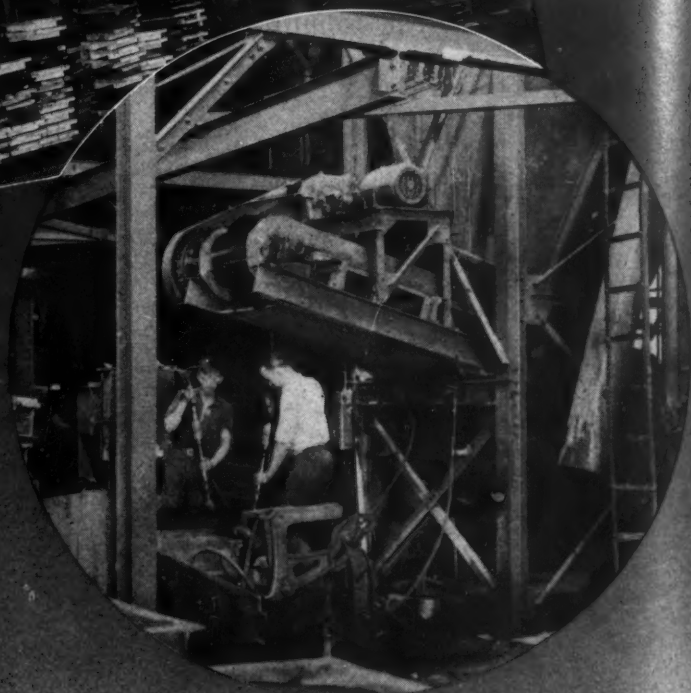
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much as we lent last year in 3. Which means that, in the approaching 7th War Loan, each of us is expected to buy a BIGGER share of extra bonds.

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Our Marines went over-the-top at Iwo Jima in the greatest, and hardest, battle in the Corps' history. Now it's *your* turn! Your quota in the 7th is needed to help finish this war, sidetrack inflation, build prosperity. So, captains of industry, plant your flag on top—like the Marines at Iwo Jima!

This year we've got to make 2=3! We've got to lend Uncle Sam in 2 chunks almost as

★
**CAPTAINS of INDUSTRY—here's your
Check List
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- ★ Get your copy of the "7th War Loan Company Quotas" from your local War Finance Chairman. Study it!
- ★ Determine your quota in E Bonds—the backbone of every War Loan.
- ★ Arrange for plant-wide showings of "Mr. & Mrs. America"—the new Treasury film.
- ★ Distribute "How to Get There"—a new War Finance Division booklet explaining the benefits of War Bonds.
- ★ Circulate envelopes for keeping bonds safe.
- ★ Display 7th War Loan posters at strategic points.
- ★ And—see that a bench-to-bench, office-to-office 7th War Loan canvass is made.

The Treasury Department acknowledges with appreciation the publication of this message by

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This Despatch Oven Layout Makes Fast Work of All Core Baking

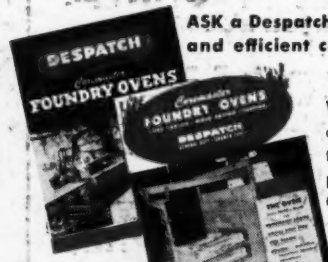


For an easy, low cost way to get all your corebaking jobs out faster, take a tip from this foundry's ingenious use of Despatch rack and drawer type ovens *together*.

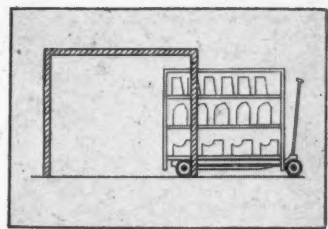
Production baking and regular runs go in 3 roomy, fast-baking Despatch rack-loaded† ovens. Production overflow, rush jobs, specials and odd-sized molds or cores go direct from coremakers' benches into two Despatch drawer-type* ovens (shown at extreme right) *without waiting*.

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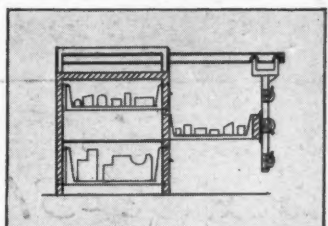
ASK a Despatch Engineer to plan a more profitable and efficient core oven layout for your foundry.



WRITE TODAY! Get these two colorful Bulletins 31 and 32. Illustrates typical advantages of Despatch Batch Type and Drawer Type Ovens: New, helpful, interesting.



† **Despatch RACK OVENS** are foundry favorites. Easily adaptable to all baking jobs. Fast-baking, rugged, easy-loading. Scores of models, gas or oil-fired. See details in Despatch Bulletin 31.



* **Despatch DRAWER OVENS** provide independent baking in each drawer. Drawers open without loss of heat from main chamber. Ideal for rush jobs or production. Gas or oil-fired; 3, 4 or 5 drawers. Drawer sizes to 48" x 72".

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OVEN COMPANY MINNEAPOLIS 14
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